The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CLII.—No. 3945] LONDON: FRIDAY EVENING, AUGUST 21, 1931 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

TO CONTRACTORS ONLY.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 15th September, 1931, for the SUPPLY of :—
(1) ELECTRICAL.
(2) MECHANICAL
ENGINEERING LABOUR in DAYWORK in Cardiff.
Forms of Tender, &c., may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1. 7416

M/2785. Assistant GENERAL MANAGER REQUIRED by the SINGAPORE HARBOUR BOARD. Salary, dollars one thousand two hundred ($1200) a month for the first year, dollars one thousand three hundred ($1300) a month for the second year, and dollars one thousand four hundred ($1400) a month for the third year. The exchange value of the dollar is at present fixed by Government at 2s. 4d. Free first-class passage for the officer appointed and, if married, for wife and children up to six years of age. Agreement for three years on the Board's usual terms, terminable at any time within that period at six months' notice on either side. The Board has a Provident Fund to which the officer must subscribe. Free unfurnished house will be provided. The Board carry on, under Government authority, an extensive business as wharfingers and warehousemen; the nett registered tonnage of ships berthed at the Board's wharves for the year ended 30th June, 1930, was 10,127,821 tons, and the grand total tonnage of general cargo and coal inwards and outwards for the same period was 3,219,415 tons. In addition, the Board operates five graving docks, ranging from 396ft. to 896ft. in length, together with a ship repairing business. The workshops attached to the graving docks are capable of executing the heaviest ship repairs. Candidates should be between 35 and 40 years of age, have first-rate technical experience, have handled a large staff and labour force, and have had considerable executive experience, and should possess pronounced business and organising abilities.—Apply for forms of application, quoting reference M/2785, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1. 7408

Royal Arsenal, Woolwich—ROYAL ORDNANCE FACTORIES TRANSPORT OFFICER REQUIRED.
The duties mainly consist in controlling transport—railways, petrol and steam lorries, electric trucks, and maintenance of permanent way.
Mechanical training in a railway workshop is desirable.
Age limits 30-45, but the upper limit may, if necessary, be extended in the case of candidates already serving under the War Department.
Salary (to which the Civil Service cost-of-living bonus is added) £406, rising by annual increments of £15 to £500 per annum. Bonus on £400 is at present £115 18s. The post will be pensionable, but the candidate selected will be required to serve on probation for a period not exceeding two years before being confirmed in his appointment.
Preference will be given to ex-Service candidates.
Application to be made not later than 8th September on form to be obtained from the CHIEF SUPERINTENDENT OF ORDNANCE FACTORIES, Royal Arsenal, Woolwich, S.E. 18. 7417

The Polytechnic, Regent STREET, W. 1.
SCHOOL OF ENGINEERING.
President of the School: Sir JOHN THORNYCROFT, K.B.E., M. Inst. C.E., M.I.N.A.
Head of the School: PHILIP KEMP, M. Sc. Tech., M.I.E.E., A.I. Mech. E., Mem. A.I.E.E.
Head of Mechanical Engineering Dept.: R. F. THOMPSON, B.Sc., Hons. (Eng.), M.I. Mar. E., A.M.I. Mech. E.
The DAY DEPARTMENT REOPENS on SEPTEMBER 15th, 1931. Entrance Examination commences September 8th, at 10 a.m.
Three-year DIPLOMA COURSES in
MECHANICAL ENGINEERING,
STRUCTURAL ENGINEERING,
ELECTRICAL ENGINEERING,
AUTOMOBILE ENGINEERING.
Practice in the Laboratories, Drawing Office, Workshop and Field.
FEE: 21 Guineas per annum.
The EVENING DEPARTMENT REOPENS on SEPTEMBER 28th, 1931. Students enrolled from 21st September.
The Day and Evening Courses are recognised for the National Diplomas and Certificates awarded by the Institutions of Mechanical and Electrical Engineers in conjunction with the Board of Education.
Prospectus free on application to the DIRECTOR of EDUCATION. 7399

The Royal Technical College, GLASGOW.
DEPARTMENTS OF ENGINEERING.
Mechanics and Mechanical Engineering:—
Professor ALEXANDER L. MELLANBY, D.Sc., M.I. Mech. E.:
Associate Professor WILLIAM KERR, Ph.D., A.R.T.C., M.I. Mech. E.
Electrical Engineering:—
Professor STANLEY PARKER SMITH, D.Sc., M.I.E.E., A.M. Inst. C.E.
Civil Engineering:—
Professor GEORGE MONCUR, B.Sc., M. Inst. C.E., M. Amer. Soc. C.E.
Mining Engineering:—
Professor DANIEL BURNS, M. Inst. M.E.
Chemical Engineering:—
Professor of Technical Chemistry: THOMAS GRAY, D.Sc., LL.D., Ph.D., F.I.C.
Complete Courses of instruction are provided, qualifying for the Diploma and Associateship of the College and for the Degree of B.Sc. in Engineering of Glasgow University.
Composition fee, 25 guineas per annum.
SESSION 1931-32 BEGINS on TUESDAY, SEPTEMBER 22nd.
Calendar, by post, 3s., and prospectus, gratis, may be obtained on application to the SECRETARY. 7223

University of Manchester.
DEPARTMENT OF ELECTRICAL ENGINEERING.
DEPARTMENTS OF CIVIL, MECHANICAL AND ELECTRICAL ENGINEERING.
Full particulars of these Courses will be forwarded on application to the REGISTRAR.
The SESSION COMMENCES on THURSDAY, OCTOBER 8th. 7397

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

Press-Tool and Fixture Design No. II. (P. 186)
(H. C. LANE.) THE ENGINEER, 21 - 8 - 31.

Technical Psychology. (P. 187)
(R. A. BELL.) THE ENGINEER, 21 - 8 - 31.

High-Tension Testing Equipment. (P. 194)
THE ENGINEER, 21 - 8 - 31.

An Automatic Regulator. (P. 203)
THE ENGINEER, 21 - 8 - 31.

Geophysics—No. IV. (P. 200)
THE ENGINEER, 21 - 8 - 31.

The Grampian Hydro-Electric Power Scheme—No. III. (P. 191)
THE ENGINEER, 21 - 8 - 31.

Report on London Waters—No. II. (P. 198)
THE ENGINEER, 21 - 8 - 31.

As Others See Us. (P. 197)
THE ENGINEER, 21 - 8 - 31.

Panama Canal Developments. (P. 202)
THE ENGINEER, 21 - 8 - 31.

INDEX TO ADVERTISEMENTS, PAGE 61.

PUBLIC NOTICES.

UNIVERSITY OF LONDON.

King's College.
FACULTY OF ENGINEERING.
CIVIL, MECHANICAL, ELECTRICAL and CHEMICAL ENGINEERING.
COMPLETE COURSES of STUDY, extending over three years, are arranged for the Engineering Degrees of the University of London and for the Diplomas and Certificate of the College.
POST-GRADUATE COURSES in CIVIL, MECHANICAL, ELECTRICAL, and CHEMICAL ENGINEERING are also provided.
HEADS OF DEPARTMENTS:
Professor A. H. JAMESON, M.Sc., M. Inst. C.E., Civil Engineering (Dean).
C. H. LOBBAN, D.Sc., M. Inst. C.E., Reader in Civil Engineering.
Professor J. K. CATTERSON-SMITH, M.Eng., M.I.E.E., Electrical Engineering.
F. S. ROBERTSON, M.I.E.E., Senior Lecturer in Electrical Engineering.
Professor G. COOK, D.Sc., M.I. Mech. E., M. Inst. C.E., Mechanical Engineering.
S. J. DAVIES, M.Sc., Ph.D., M.I. Mech. E., Reader in Mechanical Engineering.
H. W. CREMER, M.Sc., F.I.C., M.I. Chem. E., Chemical Engineering.
Professor S. A. F. WHITE, M.A. } Mathematics.
Professor A. E. JOLLIFFE, M.A. }
Considerable extensions have been made in the Engineering Department. These include a large additional drawing-office, lecture room and laboratory for Hydraulics and Strength of Materials in the Civil and Mechanical Departments, and research rooms, including Wireless Telegraphy, in the Electrical Engineering Department. Large additions have been made to the equipment of the Laboratories in the four Departments for purposes of teaching and research.
There is a College Hostel and a large Athletic Ground.
For full information apply to the SECRETARY, King's College, Strand, W.C. 2. 7412

PUBLIC NOTICES.

University of London. University College.
FACULTY OF ENGINEERING.
SESSION 1931-32.
Dean and Director of the Engineering Laboratories: E. G. COKER, M.A., D.Sc., M. Inst. C.E., F.R.S., Kennedy Professor of Civil and Mechanical Engineering.
Vice-Dean: M. T. M. ORMSBY, M. Inst. C.E.I., Edwin Chadwick Professor of Municipal Engineering and Hygiene.
Pender Professor of Electrical Engineering: W. C. CLINTON, B.Sc., M. Inst. E.E.
THE SESSION BEGINS ON MONDAY, 5th OCTOBER.
The Faculty of Engineering provides a system of training in the application of scientific principles to professional and industrial purposes.
The DEGREE and DIPLOMA COURSES lead to the B.Sc. Degree in Engineering and the College Engineering Diploma.
There are SPECIAL COURSES for students who have already undergone a partial training elsewhere, and who have attained a sufficient standard, leading to a General Certificate of Engineering.
Graduates of Science or Engineering, or students who have done work equivalent to a Degree, may be admitted to special courses of study or to prosecute original research.
CERTAIN EXEMPTIONS are granted by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Structural Engineers, and the Royal Sanitary Institute to students who have obtained certain qualifications at the College.
BUILDINGS AND EQUIPMENT.—Under the recent scheme of development about £58,000 has been expended in buildings and equipment in order to increase the existing facilities and to make the Engineering Laboratories thoroughly up to date.
The new buildings include the Cowdray Laboratory of Civil and Mechanical Engineering, the Charles Hawksley Hydraulic Laboratory, a Machine Tools Workshop, and the Edwin Chadwick Laboratory of Municipal Engineering and Hygiene.
Intending students should communicate with the undersigned, sending at the time a full statement of their previous training.
C. O. G. DOUIE, Secretary.
University College, London, Gower-street, W.C. 1. 7418

PUBLIC NOTICES

University of Manchester.
PHYSICS DEPARTMENT.
Full particulars of the Lectures and Laboratory Courses in Physics, preparing for both the Ordinary and Honours Degrees, will be forwarded on application to the REGISTRAR.
The SESSION COMMENCES on THURSDAY, OCTOBER 8th. 7398

County Borough of Croydon.
EDUCATION COMMITTEE.
CENTRAL POLYTECHNIC—MECHANICAL ENGINEERING DEPARTMENT.
REQUIRED, TEACHER with broad workshop practice and sound technical training to teach Mechanical Science to apprentices on Wednesday evenings from 7.30 to 9.30, commencing 23rd September. Fee 15s. per evening. Applications, giving full particulars of education, practical training, teaching experience, present appointments, resident address, and age, should be addressed to the Principal, Central Polytechnic, Scarbrook-road, Croydon.
R. B. MORGAN, Education Officer.
Education Office, Croydon. 7428

Sunderland Education Committee.
SUNDERLAND TECHNICAL COLLEGE.
PRINCIPAL: V. A. MUNDELLA, M.A., B.Sc.
DEPARTMENT OF MECHANICAL AND CIVIL ENGINEERING.
APPLICATIONS are INVITED for the POST of FULL-TIME LECTURER in ENGINEERING. Candidates should possess a Degree (Honours Degree preferred) in Engineering, and must have had Works or Drawing Office experience.
Salary in accordance with the Burnham Award.
Forms of application can be obtained from the Principal, the Technical College, and must be returned to the undersigned on or before Monday, 7th September, 1931, by first post.
HERBERT REED, Chief Education Officer.
Education Offices, 15, John-street, Sunderland, 19th August, 1931. 7402

The Manchester Steam Users' Association.
For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam, 20, QUAY-STREET, DEANSGATE, MANCHESTER.
Founded 1854 by SIR WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers Inspected during construction. 6762

Metropolitan Water Board.
TENDERS FOR THE SUPPLY OF CAST IRON STRAIGHT PIPES.
The Metropolitan Water Board invite TENDERS for the SUPPLY of CAST IRON and SPUN IRON SOCKET and SPIGOT STRAIGHT PIPES for the periods of Six and Twelve Months commencing 1st October, 1931.
Tenders must be submitted on the official forms (Tender No. 3), which may be obtained from the Chief Engineer by personal application at the Offices of the Board (Room 155), or upon forwarding a stamped addressed sack envelope (14in. by 9in.).
Tenders, enclosed in sealed envelopes addressed to the Clerk of the Board, and endorsed "Tender for Cast Iron Pipes," must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Monday, 14th September, 1931.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER, Clerk of the Board.
Offices of the Board, 173, Rosebery-avenue, E.C. 1, 18th August, 1931. 7423

Pontefract Corporation Waterworks.
BORE-HOLE AT EGGBOROUGH.
The Corporation of Pontefract invite TENDERS from firms of competent Boring Contractors for PUTTING DOWN a BORE-HOLE, 36in. diameter to 200ft., and 12in. diameter to the depth of 395ft., FIXING LINING TUBES, and MAKING A PUMPING TEST of the yield of Water from the Bore-hole.
The specification and drawing may be seen at the Office of the Consulting Engineer, Mr. F. Walter Hodson, M. Inst. C.E., at Bank Chambers, Loughborough, from whom copy of the papers may be obtained on deposit of cheque for Five Guineas, which will be refunded to bona fide tenderers on return of the documents. The papers may also be seen at the Office of the Borough Engineer, Mr. W. H. Newton, Assoc. M. Inst. C.E., at Pontefract.
Tenders, on the form supplied, are to be sent to the undersigned not later than the 14th September, 1931.
The Corporation do not bind themselves to accept the lowest or any Tender.
F. M. FARMER, Town Clerk.
Municipal Offices, Pontefract. 7407

PUBLIC NOTICES (continued) Page 2.
SITUATIONS OPEN, Page 2.
SITUATIONS WANTED, Page 2.
AUCTIONS, Page 62.
PATENTS, Page 2.
MISCELLANEOUS, Page 2.
AGENCIES, Page 2.
MACHINERY, &c., WANTED, Page 2.
FOR HIRE, Page 62.
EDUCATIONAL, Page 2.
BUSINESSES and PREMISES (For Sale, etc.), Page 62.
FOR SALE, Pages 2 and 62.
WORK WANTED, Page 62.

For Advertisement Rates see Leader Page.

PUBLIC NOTICES.

Administrative County of LONDON.

THAMES FLOOD PREVENTION—BATTERSEA PARK RIVER WALL.

The London County Council invites TENDERS for the RAISING and STRENGTHENING in CONCRETE of about 2800 lineal feet of existing DWARF WALL on the Embankment to the River Thames in front of Battersea Park.

The specification, form of Tender, &c., may be obtained on and after 24th August, 1931, on application to the Chief Engineer, The Old County Hall, Spring Gardens, S.W. 1, upon payment of £2 by cheque, draft or money order, to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, The Old County Hall, Spring Gardens, S.W. 1. Personal enquiries at Room 2, No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at The County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 7th September, 1931, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
Clerk of the London County Council.
7413

Borough of Bangor. County DOWN, IRELAND.

CONTRACT No. 2.

TO BRITISH MANUFACTURERS OF NON-CHOKEABLE CENTRIFUGAL PUMPING PLANT.

The Council of the Borough of Bangor is prepared to receive TENDERS for the SUPPLY and ERECTION of TWO SETS of ELECTRICALLY DRIVEN HORIZONTAL NON-CHOKEABLE PUMPS in each of Three Pumping Stations situated in the Borough. Each pump shall be capable of pumping crude roughly screened sewage at specified rates, varying between 200 and 100 gallons per minute, and shall be electrically driven and controlled by means of automatic float-operated starting gears.

The work included in the contract shall consist of the Manufacture, Supply and Erection of Pumps, Electric Motors, Starting Gears, Main Cables and Small Wiring for the whole of the Plant at the three Pumping Stations, with all Pipes, Valves, &c., inside the Pump-houses, in accordance with the Drawings, General Conditions and Specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

The general conditions, specification and copy of the drawing may be obtained by the manufacturer from the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

The works are being expedited for the relief of the unemployed, and the contract will be subject to special conditions laid down by the Ministry of Labour, Northern Ireland, for Public Utility Schemes.

Tenders, in sealed envelopes, endorsed "Tender for Sewage Pumping Plant, Contract No. 2," must be delivered at my office at Town Hall, Bangor, County Down, Ireland, on or before 12 Noon on Tuesday, the 15th day of September, 1931.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
(Sgd.) J. MILLIKEN,
Town Clerk.

Town Hall,
Bangor, Co. Down.
7410

Borough of Poole.

POOLE WATERWORKS.

TENDERS FOR THE SUPPLY AND ERECTION OF PUMPING MACHINERY.

The Corporation of Poole invite TENDERS for the MANUFACTURE, DELIVERY, ERECTION, SETTING TO WORK, and TESTING of ONE TRIPLE-EXPANSION PUMPING ENGINE, with Well and Ram Pumps, together with BOILER PLANT and other MACHINERY complete.

The plant is to be erected at the Corporation Pumping Station, Corfe Mullen, about 2½ miles from Wimborne Station on the Southern Railway in the County of Dorset.

Specification, form of Tender, drawings, &c., may be seen at the office of the Waterworks Engineer, Mr. Geo. V. Sparrow, Municipal Offices, Poole, on or after the 20th day of August, 1931, during the usual office hours.

Contractors wishing to Tender may obtain copies of the specification, form of Tender, drawings, &c., from the Waterworks Engineer, on payment of the sum of £5 5s. 0d., which will be returned on receipt of a bona fide Tender.

Tenders, enclosed in sealed envelopes, addressed to the Town Clerk, Municipal Offices, Poole, and endorsed "Pumping Machinery," must be delivered not later than 10 a.m. on the 15th day of September, 1931.

The Corporation do not bind themselves to accept the lowest or any Tender.

GEO. V. SPARROW,
Waterworks Engineer.

Municipal Offices,
Poole, Dorset.
7401

Metropolitan Water Board.

MAIN—OAKLEY-ROAD TO BROMLEY COMMON.

The Metropolitan Water Board invite TENDERS for the LAYING and JOINTING of approximately 2833 lineal yards of 18in. diameter CAST IRON MAIN, and the TAKING UP of about 1310 lineal yards of 12in. diameter CAST IRON MAIN, together with CONNECTIONS and CONTINGENT WORKS, from the South end of Oakley-road to Crown-lane, Bromley Common, in the Borough of Bromley.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201).

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained on and after Monday, 31st August, 1931, from the Chief Engineer, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and, which will be returned on receipt of a bona fide Tender, accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 Noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board, and endorsed "Tender for Main, Oakley-road to Bromley Common," must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, 21st September, 1931.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
12th August, 1931.
7409

A Qualified Mechanical Engineer

(age 30-35) is REQUIRED in a Temporary Capacity in the Department of the Chief Engineer of the London County Council. Candidates must be experienced in the Preparation of Specifications, Plans and Estimates of Schemes for Heating, Hot Water and Ventilating Installations in large modern Hospitals and Institutions and of Alterations and Additions to existing Installations.

The rate of pay attaching to the position is £4 to £6 a week, according to qualifications.

Applications must be made on the official form, obtainable by sending a stamped addressed foolscap envelope to the CHIEF ENGINEER, London County Council, The Old County Hall, Spring-gardens, S.W. 1, to whom applications must be returned not later than 31st August, 1931.
7422

PUBLIC NOTICES

British Non-Ferrous Metals RESEARCH ASSOCIATION.

RESEARCH DEVELOPMENT. — ASSISTANT REQUIRED for the Development Section of the British Non-Ferrous Metals Research Association.

The task of this Section of the Association's work is to foster the industrial utilisation of the results of scientific metallurgical research by effective interpretation and practical demonstration.

The present opening is mainly, but not necessarily exclusively, in connection with the application of certain lead alloys for water pipes, cable sheathing, electric accumulators, &c.

Only candidates with the experience and qualifications referred to below should apply.

Applicants should be metallurgists or engineers with metallurgical experience, preferably university graduates, combining scientific training with industrial and commercial experience. The work calls for technical ability, tact and personality in order to assure satisfactory contact and co-operation with the heads of both small and large industrial concerns.

Salary up to £500 per annum, according to age, qualifications and experience.

Applications by post should give full particulars and references or testimonials and should be addressed to the DIRECTOR, British Non-Ferrous Metals Research Association, Regnart Buildings, Euston-street, N.W. 1.
7405

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

Box 7310—Situation has been filled.

WANTED, Experienced ENGINEER with Detailed knowledge of Modern Complete Production of Safety Razor Blades.—Address, P1405, The Engineer Office. P1405 A

ASSISTANT ENGINEER REQUIRED by London Firm of Engineers. Some practical experience and good education essential. State age and full particulars.—Address, 7426, The Engineer Office. 7426 A

ASSISTANT ENGINEER REQUIRED in the Office of Importers who service highly productive Industrial Machinery after application of elaborate Electrical Equipment. Must have varied experience and be able to conduct Office Routine Work and Control Outside Erecting Staff.

Salary £350 p.a.

Address, stating age, 7421, The Engineer Office. 7421 A

WORKS MANAGER is REQUIRED for an Important Manufacturing Undertaking. The qualifications necessary are a practical and first-hand knowledge of Rolling Mills practice, and capacity to Control Rolling Mill Operations and Finishing Plant. The position calls for skill in Technicalities, Organisation and Co-ordination of Departments through Departmental Heads to ensure an even Flow of Output on Economical Lines. The production consists of solid Drawn Steel Tubes, and priority of consideration will be accorded applicants who have a thorough knowledge and practical experience of the working of Steel in the production of Solid Drawn Tubes.—Address, in first instance, stating age, technical qualifications and tube manufacturing experience, 7415, The Engineer Office. 7415 A

WANTED, SENIOR DRAUGHTSMAN, with Experience in the Design of Vertical Air Compressors. State age, salary and experience.—Address, 7431, The Engineer Office. 7431 A

THREE Smart MECHANICAL DRAUGHTSMEN REQUIRED (age 25-30) in S.W. London. Experience in Sheet Metal and Light Steel Work an advantage. State age, experience and salary required.—Address, P1398, The Engineer Office. P1398 A

SITUATIONS WANTED.

B.Sc., A.M.I. Mech. E., Smart Live Man (in London), possessing energy and initiative, SEEKS ADVANCEMENT, RESPONSIBLE POSITION; 17 years' experience, workshops and D.O., marine, power station, W.T. boiler, chemical, and blast-furnace plants, supervision, correspondence. Address, P1403, The Engineer Office. P1403 B

B.Sc. (Hons.) in Mech. Eng., Grad. I.E.E., C. and G. of L., Final elect., 7 years' mech. experience, age 26, DESIRES POST, home or abroad.—Address, P1420, The Engineer Office. P1420 B

CIVIL ENGINEER (33), Public School and Graduate, three years' apprenticeship, seven years' experience railway construction and maintenance, D.O. and estimating experience, SEEKS APPOINTMENT in England.—Address, P1394, The Engineer Office. P1394 B

ELECTRIC TRACTION ENGINEER (32), with experience in both the design and maintenance of electric rolling stock, SEEKS POSITION with a Firm of Consultants.—Address, P1401, The Engineer Office. P1401 B

ENGINEER (36), Wh. Ex., A.M.I. Mech. E., Thorough theoretical and practical training, wide sales and works experience, used to running business and controlling men, DESIRES a RESPONSIBLE APPOINTMENT.—Address, P1411, The Engineer Office. P1411 B

GRAD, I.E.E. (30), Single, Engl. Public School education, German Eng. Degree, DESIRES POSITION of TRUST and RESPONSIBILITY at home or abroad.—Address, P1416, The Engineer Office. P1416 B

JUNIOR MARINE ENGINEER REQUIRES SITUATION, steam or Diesel; five years' varied workshop experience.—Address, P1407, The Engineer Office. P1407 B

MECHANICAL ENGINEER (A.M.I. Mech. E., M. Am. S.M.E.), 20 years' experience covering design, operation, sales and executive, from works to director, personal knowledge most foreign markets, DESIRES APPOINTMENT where there is scope for ability, home or abroad.—Address, P1423, The Engineer Office. P1423 B

MECHANICAL ENGINEER, DRAUGHTSMAN, DESIGNER, would LIKE EXTRA WORK, detail or design for Spare Time; thoroughly experienced, quick, accurate, reliable.—Address, P1414, The Engineer Office. P1414 B

MECH. ENGINEER (32), Twelve Years I.C. engines, theoretical and practical, used to authority and handling men, author four books, REQUIRES responsible POSITION.—Address, P1361, The Engineer Office. P1361 B

STRUCTURAL ENGINEER (31), B.Sc. Hons., Over 12 years' experience, steel construction, some ferro-concrete, general building work, quantities, estimating, and administration, SEEKS RESPONSIBLE APPOINTMENT in London.—Address, P1418, The Engineer Office. P1418 B

CHEMICAL PLANT DESIGNER DRAUGHTSMAN, with publicity experience, DESIRES POST, development work preferred.—Address, P1402, The Engineer Office. P1402 B

SITUATIONS WANTED (continued).

DRAUGHTSMAN (27), 5 Years Tech. College, 5 years shops, 6 years D.O., gears and general experience, 11 years one firm, WOULD LIKE CHANGE.—Address, P1395, The Engineer Office. P1395 B

DRAUGHTSMAN (29), London, 3 Years Tech. College, 6 years shops, 8 years D.O., pumps, compressors, gears and general experience; excellent refs.—Address, P1419, The Engineer Office. P1419 B

ENGINEERING DRAUGHTSMAN (33), with Purchasing, costing, manufacturing and sales experience, SEEKS progressive POSITION in which hard work, originality and tact will be assessed at true value.—Write, Box D, c/o Brown Gould, Ltd., 11-12, Salisbury-square, London, E.C. 4. 7372 B

JUNIOR DRAUGHTSMAN (21) SEEKS POSITION in drawing-office or similar post; 3 years technical college, 2 years workshops, and 3 years' D.O. experience; Junior National Certificate; disengaged.—Address, P1417, The Engineer Office. P1417 B

STRUCTURAL DRAUGHTSMAN, with First-class experience in designing, estimating and detailing steel-framed buildings, large span roofs, and builders' steelwork generally; can furnish excellent references and START IMMEDIATELY.—Address, P1422, The Engineer Office. P1422 B

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A Seven-Day Journal

The South Scotland Electricity Scheme.

THE South Scotland electricity scheme prepared by the Electricity Commissioners has just been adopted by the Central Electricity Board, and the work involved is to be begun as soon as possible. This is the ninth of the ten schemes designed under the Electricity (Supply) Act, 1926, to cover the whole of Great Britain. The remaining scheme will cover North Scotland, but as this is a sparsely populated area, for all intents and purposes the work of mapping out Great Britain for the supply of electric power is complete. The South Scotland scheme covers an area of 4308 square miles, but much of it is forest or moorland and the population is approximately 255,954, representing the low average density of about fifty-nine persons per square mile. The area contains some important water power resources, which, if properly developed, could produce a supply of electricity far in excess of the needs of the whole area. At present there are three generating stations in the area—Galashiels, Hawick and Dumfries—and the present consumption is mainly concentrated in the parts immediately surrounding these stations. In 1935 the consumption is expected to be 16·88 million units and in 1943 34·41 millions. Under the proposals set forth in the scheme issued early this year the existing station at Galashiels and five new water power stations in Galloway will be operated for the Board. The system of high-pressure main transmission lines has been laid out to enable the Board to develop the area to the best advantage and to export the energy generated at the hydro-electric stations to other areas. The main transmission system will comprise 150 route miles of line and seven transforming stations, while the secondary transmission will involve four transforming stations. The total expenditure on the scheme is estimated at £3,468,234, and it is expected that in the ten years from 1934 to 1943 there will be a saving of £103,876 to the three undertakers in the area and a saving of £65,496 to the Board in respect of energy exported to the areas of the neighbouring schemes.

The Graf Zeppelin's Flight.

THE German airship "Graf Zeppelin," which left Friedrichshafen at 7.5 on Tuesday morning last for England, crossed the Channel to Hastings and in the early evening cruised along the coast to Brighton. She then made for London, and arrived at Hanworth Aerodrome at six o'clock, almost an hour before she was expected. After dropping the mails, she then set off for a cruise at a low altitude over London, and was seen to advantage under ideal weather conditions. She returned to Hanworth at 7 p.m., and within ten minutes was safely landed. Mr. Montague, the Under-Secretary for Air, welcomed Dr. Eckener and the officers and crew on behalf of the Secretary for Air and the Air Council, and referred appreciatively to the success of the "Graf Zeppelin," and the assistance which Dr. Eckener had given, and was in the future willing to give, in furthering the cause of British airship development. Mr. Montague then presented to Dr. Eckener an inscribed gold box, marking the occasion of his visit. Dr. Eckener said that he considered it a privilege to have been of some service to the cause of British airship development, and he felt confident that they would work together in the future even more closely than in the past. Thirty years of active experience had convinced him of the practicability of the airship for air transport, not in competition with aeroplanes, but in a complementary sense. His experience, however, showed him very clearly that such development could only be successfully achieved on a world-wide scale, and with the aid of a very complete system of international co-operation, in which he felt convinced that this country would play an important part. Later in the evening the airship left on a 24-hour cruise over the British Isles, and returned to Hanworth Aerodrome about 7 p.m. on Wednesday evening, after which she left again for Germany.

Factory Accidents.

IN the annual report of the Chief Inspector of Factories and Workshops for the year 1930, which has just been published by H.M. Stationery Office, it is stated that the total number of accidents reported has decreased in comparison with the figures of the previous year from 161,269 to 144,758, the fatalities being 982 and 899 respectively. The cause of the decrease is mainly laid to the account of the prevailing depression in industry, but at the same time it is regarded as not unfair to assume that some of the reduction followed upon the installation of safety devices. A considerable reduction in the number of accidents, it is stated, occurred in those industries in which safety organisation had been most developed. The building trade is listed among the few trades in which there was an increase. The number of fatalities was 125 and the non-fatal accidents also showed an increase. Although the chemical industries also showed a considerable increase in fatal accidents, this fact could be accounted for very largely by the occurrence of explosions at Castleford and Liverpool, which between them accounted for twenty-four deaths. Among the industries which can record a reduction in the number of accidents, the metal industries, which include smelting, conversion, rolling and founding, reported 120, shipbuilding 74, and docks 74 fatalities. In an introduction to the report Sir Gerald Bellhouse, the Chief Inspector of Factories, points out that a large proportion of the accidents occurred owing to failure of the human element to pay due regard to safety while carrying on its work.

The Schneider Trophy.

YET another fatal accident to a Schneider Trophy pilot must be recorded. Last Tuesday, when taking off for his first flight in one of the Supermarine S6A seaplanes, which competed in the race in 1929, Lieut. Brinton, the youngest of Britain's team of pilots, was killed. Just after rising from the water the machine dived into the sea, and subsequent examination of the wreckage showed that it had been badly damaged by the impact. As soon as the accident was observed many motor boats set out towards the scene, but it was found impossible to rescue Lieut. Brinton, and when the fuselage had been drawn ashore his body was found at the tail end where it had apparently been forced by the rush of water. The crash occurred at about eight o'clock in the evening, but as yet nothing is known for certain as to the cause of the disaster. This fatality is the eighth which has occurred to pilots engaged in competing for the trophy, and is the third this year. France and Italy, the two other competitors in this year's race, have each suffered the loss of a famous pilot. Practice flights until the day of the accident had been much interfered with by the unsuitable weather, and Lieut. Brinton's was the first after a delay of several days. We understand that this year the pylons which mark the course will be distinguished by a new colour scheme. The black and white chequer used during the last race was not very satisfactory, since the pilots had difficulty in observing the pylons, and this year they are to be painted an orange yellow colour. Experiments are also being conducted with searchlights trained on each pylon from the one beyond it. The draw for the starting order has now been made and has resulted as follows:—1, Great Britain; 2, France; 3, Italy. The first machines from each country will start in this order, the second and third strings following on in the same manner. As this is the case, it seems probable that the French and Italian pilots will know the speed which they will have to exceed to beat our machines, but we shall not know of what their machines are capable until our participation in the race is almost completed.

Iron Roads.

AN experimental iron road surface has been laid down on a portion of the Romford-road at Stratford, and last Tuesday Mr. Frank Hough, chairman of Henlys, Ltd., drove the first car over the new stretch of road. The statement is made that it is very difficult to make a car skid on the new surface, while there is a noticeable reduction in noise when traffic passes over it. The road is constructed of cast iron blocks made by the Stanton Ironworks, Ltd., who are interesting themselves in the new scheme. The blocks are about 2in. deep and shaped on their upper surfaces in a diamond pattern, similar to that found on Goodyear tires, from which, indeed, the design has been copied. The grooves in the pattern are about ¼in. deep. The blocks are laid in bitumen and experiments carried out at the makers' works suggest that there is no tendency for them to become displaced. At present only about 60ft. of road has been laid in this manner, but from this length it is hoped that sufficient experience will be gained to justify its use in other localities. Its life, at least, should be long, and the claim is made that, once laid, it would require very little attention.

New P. and O. Liners for Eastern Service.

ON Tuesday, August 18th, the twin-screw liner "Carthage," built for the Eastern service of the Peninsular and Oriental Steam Navigation Company, was safely launched from the Linthouse Yard of Alexander Stephen and Son, Ltd. The new liner, together with her sister ship the "Corfu," which is now approaching completion in the same yard, will shortly be ready for service. Each of the new liners has a length over all of 545ft., a breadth of 71ft., and a depth of 46ft., with a measurement of 14,000 gross tons. The designed draught is 29ft. 9in., and with 15,000 S.H.P. the speed is 19½ knots. The straight stem raked forward, with the two masts and two funnels and a cruiser stern, give the ship an impressive appearance, which is enhanced by the black hulls and P. and O. white lines and upper works. Accommodation is arranged for 180 first class saloon passengers and 200 second class saloon passengers, and officers, engineers, and crew numbering 300 persons. The six holds and 'tween deck spaces provide a cargo capacity of about 8500 tons measurement, which includes 1000 tons of insulated space, in addition to strong rooms for mails, bullion, and special cargo. The propelling machinery comprises a twin-screw arrangement of Parsons single-reduction geared turbines, each consisting of a high-pressure, intermediate pressure, and low-pressure turbine, to which high-pressure steam at 400 lb. pressure and with a total superheated temperature of 725 deg. Fah. is supplied. The condensers are of the latest Weir regenerative type, each condenser having a surface of 7800 square feet and operating on the closed feed system, with a guaranteed vacuum of 28in., with a sea temperature of 82 deg. Fah. Steam is raised in four Yarrow water-tube boilers of the five-drum type, with Yarrow superheaters and air heaters. The boilers, which include two auxiliary steam, low-pressure boilers, are all fired on the Clyde oil-burning system under forced draught. The auxiliary machinery is largely electrically operated, and in order to provide the necessary current there are three 350-kW turbo-generators and one 50-kW oil engine driven generator set. The refrigerating plant is of the latest J. and E. Hall CO_2 type, with provision for both cargo and domestic services.

Refloating H.M. Battleship Emperor of India.

ON Saturday of last week, August 15th, H.M. battleship "Emperor of India," which since June 11th has rested on a sand bank in 30ft. of water near the Owers Light, off Bognor Regis, was successfully refloated and was towed into Portsmouth Harbour, where she was dry-docked for repairs prior to her sale for breaking up. The battleship was severely damaged by practice gunfire in June last, and Mr. E. F. Cox, of Cox and Danks, Ltd., was invited by the Admiralty to prepare and supervise a salvage scheme. Work was begun early in July, and a combined plan of pumping and raising by compressed air was adopted. The principal difficulty met with was the patching of a large rent in the starboard engine-room side of the ship, some 15ft. by 10ft., which was caused by a bursting shell, the explosion of which also fractured and blew off their seats the main condenser inlet valves in the centre engine-room. With the pumps available, it was not possible to deal with the inflow of water into the ship. Air-locks were fitted on the centre and the starboard engine-rooms, and with a pressure up to 13 lb. per square inch it was possible to repair temporarily the damage, and to obtain 90 per cent. of the buoyancy of these spaces. It was also necessary to put No. 1 boiler-room under air pressure in order to patch a shell hole, this space being afterwards pumped out, along with a flooded shell-room. On Wednesday of last week a preliminary attempt to raise the ship showed the necessity of making adjustments in the distribution of buoyancy, while on Thursday a further attempt failed owing to the very calm sea, which did not give sufficient movement to free the ship from her bed of shingle and sand. On Friday, after a further 2000 tons of loose water had been pumped out under rough weather conditions, the ship left the bottom and was afterwards towed to Spithead by Admiralty tugs. She was later dry-docked at Portsmouth for repairs. The whole of the operations were carried out by the Admiralty under the personal supervision of Mr. E. F. Cox and his staff, and the work was, we are given to understand, carried through without a single hitch.

Oil from Coal.

FURTHER to our Journal Note of August 7th, dealing with Professor F. G. Donnan's views on the importance of the hydrogenation process for the production of petrol and fuel oils from British coal, we have received from Sir Harry McGowan, the chairman of Imperial Chemical Industries, Ltd., a statement in which he confirms the fact that the 15-ton Billingham plant produces some 60 per cent. of the dry coal treated by hydrogenation as refined petrol. Sir Harry also suggests that although high pressures and temperatures are necessary in the hydrogenation process, the experience of his firm in the technique of ammonia manufacture has enabled all difficulties which have so far arisen to be satisfactorily overcome. As regards the manufacture of hydrogen, neither the quantity which would be required or the price at which the gas could be made presents any obstacle to the successful development of the hydrogenation process on an economic scale. It will, Sir Harry further suggests, be quite practicable to build a 1000-ton plant for the production of petrol from clean dry coal at a small profit, which, while in view of the present low and uneconomic price of imported petrol might not at present attract capital, nevertheless would, with a slight rise in price, render the hydrogenation process a self-supporting commercial proposition. It may be recalled that Imperial Chemical Industries, Ltd., is associated with the recently formed International Hydrogenation Patents Company, which has had experience in the production of 100,000 tons of petrol per year from brown coal and brown coal tar. Commenting upon and discussing the above statements, Sir Richard Redmayne, in a recent letter to *The Times*, remarks that few manufacturing processes have suffered more from exaggerated anticipation than has that of low-temperature carbonisation, and he expresses the hope that the same error will not be repeated in the case of the liquefaction of coal.

Press-Tool and Fixture Design.

By HENRY C. LANE.

No. II.—BENDING TOOLS (*continued*).*

II. Compound Action Bending.

In the three accompanying reproductions—Figs. 9, 10, and 11—are illustrated a fairly simple set of compound action bending tools for use with a single action press. The straight length of wire, 34½in. by 0·202in. diameter, 75-ton tensile spring temper, shown at A in Fig. 10, is bent to form a roughly pentagonal eye, as shown at A′ in Fig. 11.

Prior to the construction of these tools, the only really satisfactory method of handling the job had

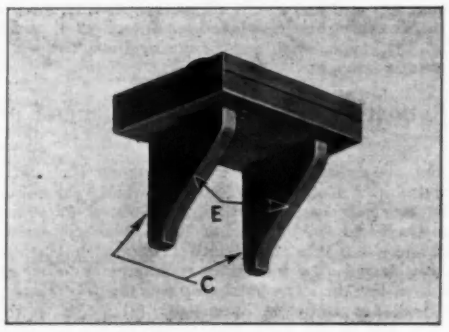

Fig. 9

been in two operations absorbing 90 minutes per gross finished, but with the introduction of the design illustrated this time was reduced to 10 minutes per gross without undue strain on the operator. In all probability, the principle of the design is self-explanatory from the three engravings, but points cropped up in the design that cannot be gathered, except from a full description of the working and explanation of the limitations imposed by presses at my disposal and the type of material to be handled. First, I had no power press that would allow the two arms of the wire—17in.—to swing up without striking the ram or other part of the press, and the tools

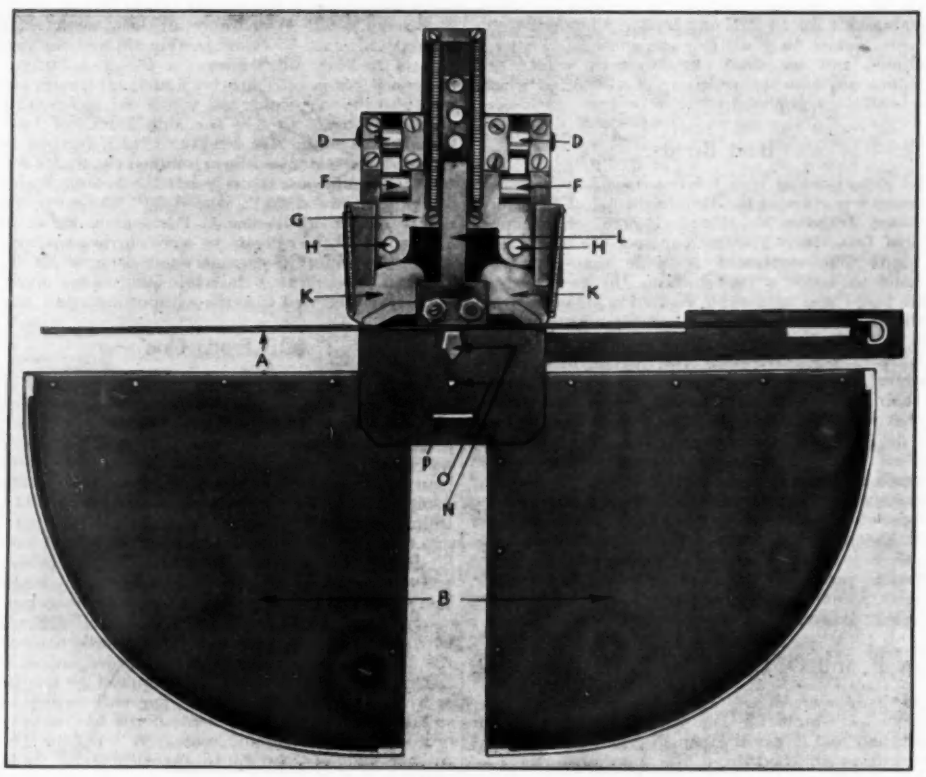

Fig. 10

therefore had to be designed on the horizontal principle. Secondly, although in the previous section I referred to the ductility of this class of material, we found that a stronger spring was obtained by reducing the ductility to a point that would only allow us to bend at right angles without breakage. Reference to the finished shape of the wire, as shown at A′ in Fig. 11, will show that the two bends at the extreme end of the eye are very little under the 90 deg. through which the material can regularly be bent without breakage, and with this in view, in addition to the desirability of subjecting the tools to as little strain as possible, it was decided to approximate as closely as possible to the true bending principle, as explained in the previous section. I have already indicated that it is not feasible in practice to follow the true bending path of the material, and have stated that a slight compression tendency is less harmful than a slight drawing tendency, and this aim is carried out in the tools illustrated in so far as these two main bends are concerned. That is to say, that taking the measurements on the outside of the bent wire a lesser distance exists between the points of contact with the bending points of the die after these first bends are completed than between the same points when the wire is straight. The remaining two bends on each arm of the "spring eye" are, as will be seen, of much less severity, and as such a plain V "draw-bend" principle is in effect adopted.

The operation of the tools is quite simple. A stationary form punch composed of a round peg O and shaped block N are let into the die shoe. The triangular pad M in Fig. 11 is held by the die shoe and the supporting strap L in Fig. 10. This pad supports the dead centre of the wire during bending, and prevents an extra bend occurring in the flat end of the finished piece. Two specially shaped rockers K are hinged on pegs set in the die shoe and carry out the actual bending of the wire around the form punch. The bending points of the rockers are hardened steel renewable inserts, as the wear is quite considerable in each case. The rocker drive slide G is fitted with rollers at F, which receive the power impulse from the angle faces E of the punch, Fig. 9—which is supported on the perpendicular faces C by the rollers D carried on the die shoe—and the impulse is transferred through two more rollers carried on the pins H to the outer faces of the rockers. It was found necessary to fit the supporting strap L, shown in Fig. 10, to overcome continual breakages of the rocker pivot pegs, owing to the great strain to which they were subjected during the first and last portion of the pressure stroke. Actually the last portion of the pressure stroke exerts by far the greatest pressure, as the wire is then being bent in four separate places at the same time, and this is as it should be, since the press itself gives the greatest pressure towards the bottom of its stroke. Attention should be paid to the profile of the cam faces of the rockers. To produce a perfect shape, it was found desirable to exert a final squeezing pressure around the formed wire. A plain radiused face for the cam subjected the rocker drive slide to strains at an angle to the pressure exerted from the angle driving punch, and to reduce this to a minimum the cam faces were shaped, as indicated, in order to present a face at right angles to the driving pressure when the final squeeze was taking place. Quadrant guards B of sheet steel were fitted to the die shoe to allow the arms of the wire to swing round during bending without danger to the press operator, a gap being left between the two quadrants to allow the formed wire to fall after stripping from the form punch by a unique stripping device, shown at P. This stripping device is merely a short piece of ¼in. silver steel, bent to a U-shape, the two legs of which are driven into two suitable holes in the die shoe. The bends are transformed from the natural radii to 45 deg. angle faces extended from the surface of the die shoe to the full ¼in. thickness of the bar, the angle faces are polished and the whole U piece hardened and tempered. As the wire is being bent, it follows closely to the surface of the die shoe, and by the time the two arms of the wire reach the angle faces of the stripper bar they are held so tightly that they cannot rise above the die shoe except away from the bending points of the rockers. The wire arms are therefore sprung over the stripping bar, and a violent vibration of the arms is set up perpendicularly by the sudden lift and horizontally by the rapidity of the final portion of the bend reversing the direction of travel of the arm ends of the wire. As soon as the rockers release the wire, these compound vibrations and stored spring lift, aided by the over-balancing weight of the free ends of the arms, result in the formed wire shaking itself free and falling through the gap provided between the quadrant guards. It might be added that without this stripping bar, or if a formed piece is tapped back into position, the wire can only be removed with considerable difficulty, unless the arms are pulled open to an extent that frequently alters the final shape of the piece.

Summarising the operation in actual sequence:—The straight wire is dropped between the supporting peg M and the form punch N, and gauged for position from the one end, as shown in Fig. 10. The main angle drive punches are supported by the rollers D, while transferring the stroke to the rocker drive slide G, *viâ* the rollers F, and thence *viâ* rollers carried on the pegs H to the cam faces of the bending rockers, which bend the wire, first, to a flat-based V shape

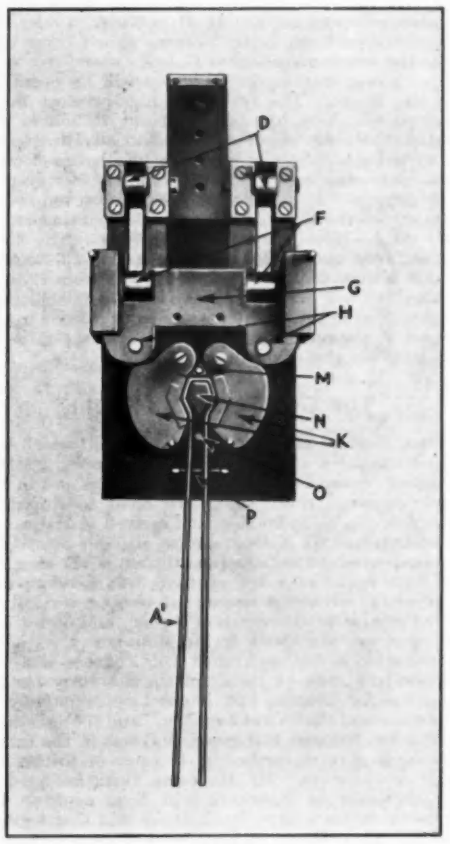

Fig. 11

and on to the final shape, as shown, the final squeeze pressure being exerted on the specially shaped cam faces and transferred therefrom to the complete shape of the wire around the form punch, as represented by the shaped block N and round peg O. Bending rockers and rocker drive slide are returned to their original positions as the punch rises by the springs shown in Fig. 10, and during this return stroke the formed wire shakes free and falls clear, leaving the die open for feeding the next length of straight wire.

III. Compound Action Bending (ii.).

In the three illustrations accompanying this section a development of the principle underlying the tools described in the preceding section is shown.

Fig. 12 shows a section of hot-rolled round-edged bevel mild steel bar from which the blank shown in position on the bending die at A in Fig. 13 has been taken. The actual shape of the blank is immaterial, except in so far as gauging for bending is carried out on serrations on the narrow edge of the metal. Normally the blank would be gauged from the end, but in the present case each end of the blank has been bumped to a rough round section along a length of ¾in., and slight variations in the rolling result in corresponding variations in the overall length of the blank. In Fig. 14 the bending operation has been carried out on the blank as shown at A, and is composed of two easy radius bends at B and two dead sharp angle bends at C. Each of the four angles thus made has arms at less than a right angle, and these angles can be controlled to suit varying requirements or to give the same angle on varying tempers of steel simply by raising or lowering the setting of the ram of the press. The serrations previously referred to

* No. I. appeared August 14th.

have to be in dead relation to the two radius bends B, hence the advisability of gauging therefrom.

The first difficulty that had to be surmounted is shown clearly in Fig. 12, which is a sectional end view of the bent blank. It was necessary to cant the section at the angle shown, but the metal persisted in taking the path of least resistance, giving an angle face exactly opposite to that required. The form punch was, in the first set of tools, made on the same principle as that shown in the wire forming tools previously described. To overcome the dropped angle, this form punch was built up to support the thin edge of the metal, in addition to the thick edge, but this merely acted as a slide to throw the blank clear of the tools when the bending rockers came into contact. It was impossible to carry the form punch over the small radius of the metal section to prevent this throw-out action, as the four bends, being each less than a right angle, prevented the finished work from being removed from the die, except in a direct vertical line. With all this information in hand, I came back to knowledge similar to that given in the first section, that the bend could be handled quite satisfactorily with hammer and vice; obviously it was necessary to have a self-acting vice incorporated in the tools, and thus arose the second difficulty. I had before me the experimental tools with bending rockers and fixed form punch. The rocker pivot centres had been carefully located to give a minimum of bending-point slide along the blank, and the centres thus located gave insufficient room for a moving vice jaw to give a firm pressure along the best part of 4in. and a throw of not less than ¼in. To allow for variations in rolling, a self-acting vice either had to have a certain amount of "give" for the thicker sections, or it had to employ a design of jaw that would hold the blank in correct position without actually gripping the blank tightly, and it was therefore obvious that the form punch—as one jaw—would have to be

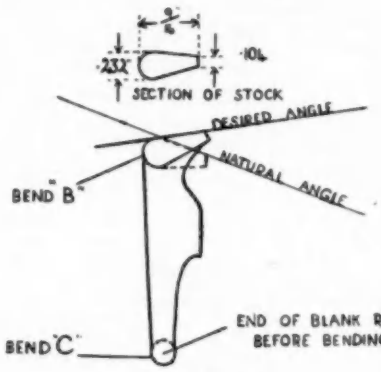

FIG. 12

moulded to give the correct cant, while the opposing jaw was correspondingly moulded, and, in addition, was provided with a lip to overhang the section to be held. From this it followed that I had to utilise the form punch as the moving jaw of the vice.

In the wire-forming tools previously described, the rocker drive slide was reduced to a minimum in length that would take and transfer the thrust without jamming, but I had no press with a ram or bed wide enough or deep enough to accommodate all the necessary bending parts between two driving slides similar to the one employed on the wire-forming tools. To prevent jamming, therefore, I had to bring my two main driving punches closer together, housing the driven rollers more towards the working points of the drive slides and extend each drive slide to form a frame which would allow of the provision of the very necessary supporting rollers for the main drive punches.

The only remaining difficulty that had to be surmounted was the immediate tendency of the arms of the blank to drop during bending if the section of the metal was satisfactorily held at the required angle. When starting on the new tools, I considered that a grooved bending rocker would surmount this difficulty, but I eventually found that after very little wear the blank arms commenced to slip out of the grooves, and I found it necessary to fit auxiliary rocking pieces to support the ends of the blank during the first portion of the bend, and to provide grooves in the form punch shoulders to continue the support during the final short portion of the stroke.

In actual production, great trouble was experienced with the rolling mill scale from the metal chipping off and continually clogging the slides, but this was satisfactorily eliminated by providing the holes T in Fig. 13 in the base plate, and fitting felt pads to each of the drive slides. In the case of the rocker drive slide, these pads are extended on sheet steel arms under the rockers, so that any scale that falls when the blank is removed is definitely brushed into the clearing holes.

Bearing the foregoing details in mind, the description of tools themselves can be readily followed. In Fig. 13 the long-throw angle punch P is the driving punch for the actual bending stroke, while the short-throw angle punch R is the punch that actuates the vice action on the die.

In Fig. 13 the complete die is shown with the straight blank in position and the tools in the fully "up" position; while in Fig. 14 the tools are shown with all return springs removed and the tools in the fully "down" position. Lettering in both illustrations for reference is identical. The rockers H are designed on the same "cam" principle, utilised for the wire-forming tools, so that the final squeeze of the thrust is met with the rocker-driven faces at right angles to the line of thrust; the bending point of each rocker is the only point where there is any appreciable wear, and is in consequence a hardened steel renewable insert. The rocker pivot pins G are screwed into the die shoe, and are supported on their upper ends by the plate F, which is screwed and strongly dowelled to a suitably faced steel pad let into the die shoe to form the fixed jaw of the self-acting vice action. The blank end supporting auxiliary rockers O are hinged on screw pegs close to the

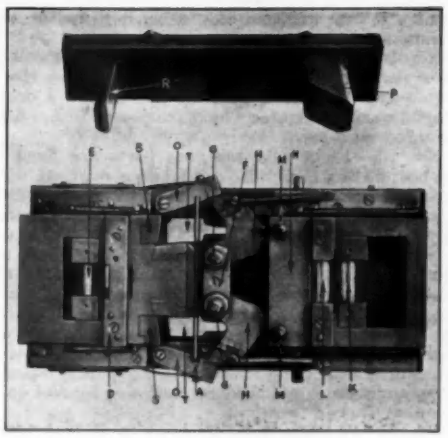

FIG. 13

shoulders of the form punch. Light flat springs are fitted to the outer sides of these auxiliary rockers, and these springs, operating on the edges of the die shoe keep the inner edges of the auxiliary rockers close to the bending points of the bending rockers until the blank reaches the shoulders of the form punch, and enters the grooves provided in these shoulders. The shoulders S of the form punch are hardened steel renewable inserts. The roller E is the supporting roller for the punch R. The driven roller of the form punch is not clearly discernible in the engravings, being carried on the cross bar D, which is, in effect, a miniature plummer block having arms extending downwards into the form punch and carrying the driven roller to the horizontal centre of pressure. The gauge for the serrated edge of the blank is hidden by shadow in the photographs, but is composed of suitably shaped bars driven horizontally into the fixed

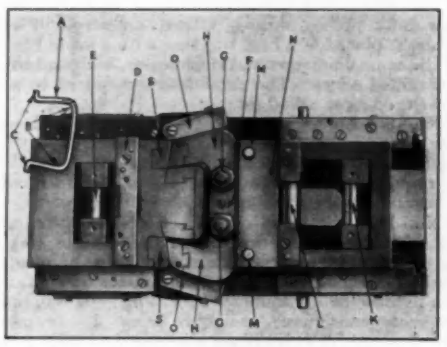

FIG. 14

vice jaw and extending under the form punch to provide a fixed position for the blank transverse to the slide no matter on which side of the gap between form punch and fixed jaw the blank may be placed. This type of gauge was necessitated by the form punch throw being over the thickness of the metal. If a gauge of only 0·104in. thick had been fitted to the face of the fixed vice jaw, it would have been quite possible to place the blank in such a position that it would be pinched between the form punch and gauge instead of being held in the vice in the correct manner.

Apart from the positioning of the rollers, the rocker drive slide N is exactly similar to that of the wire-forming tools, two driving rollers being mounted on the pegs M. The roller K supports the punch P and is let into the base plate on two upright carriers exactly the same as the roller E. The driven roller L is carried to the centre of pressure on two L-shaped bearings, which serve the same purpose as the cross bar roller carrier D.

In action the blank is placed in position as shown in Fig. 13. The punch R operates the vice action, and as soon as this is completed it merely maintains the grip with its parallel face, while the punch P actuates the bending processes. All moving parts return under spring tension when the punch rises, and the bent blank is easily removed from the form punch by hand on account of the taper moulding that gives the required cant to the outer surface of the bent blank.

Prior to the use of these tools the best production time, without obtaining absolutely satisfactory results, was at the rate of 59 minutes per gross finished. This time is now reduced to 15¾ minutes, and complete satisfaction in the finished product obtained.

(To be continued.)

Technical Psychology.

By R. A. BELL.

DURING the inspection of a large number of engineering factories on the Continent of Europe, it was quite interesting to see the extent to which investigations were being carried out with the object of determining the suitability of applicants for, and the progress made by employees in, their various occupations. Of the not inconsiderable number of firms which were found to have given the matter attention, the majority had confined their attention to the question of the suitability of candidates for various classes of employment; a smaller number had installed apparatus for determining acquired technical efficiency, and a still smaller number had adopted both classes of inquiry. Only a few employers carried out periodical tests covering the maintenance of efficiency, retention of nerve, &c.

It is possible that certain of the factories visited—some 450 in sixteen different countries of Europe—may have had in force some system of psychological selection, but it was not mentioned. On the other hand works managers and others in those places where such methods had been introduced, were as a rule so rightly proud and pleased with the results obtained, that the probability is that in those cases in which nothing was said about it, nothing had been done. A brief description of some of the tests devised and of the apparatus used in conducting them is given below, and whilst no one factory was found to be using all the methods described, some few were employing quite a large number of them. The largest number of tests noted at any one factory was thirty-three, namely, in a large iron and steel works, employing about 35,000 hands. All the firms which had introduced any of these methods were unanimous in their opinions as to the value and importance of the tests.

The primary object might be said to examine the candidate's ability to see, to feel, and to hear; but the tests do, in fact, go very much farther than this, as they not only indicate the acuity of these senses, but involve the application of some intelligence, and in some cases a lesser or greater amount of acquired manipulative skill. Practically all of them call for a considerable power of observation and sense of comparison. The tests can be conducted in different ways. A time limit may be set in which the candidate must complete the task, and he may then be considered to have passed or failed in that test, or the degree of accuracy attained at the conclusion of the time may be estimated, and the candidate awarded marks accordingly. Alternatively, the time taken to finish each test can be recorded, and the marks read inversely, the shortest time giving the lowest number of marks, in which case a small score is the best. An important point is to have a suitable system of recording the results of the examinations. A special form for each different class of candidate being tested is a very great convenience—see the note, "Physico-technical Laboratory," below.

To summarise the tests described below, Numbers 1, 2, 16, and in part Number 40, are quite elementary tests as to the candidate's capacity for seeing, feeling, and hearing. Number 3 calls for colour sense, and some slight manipulative skill. Numbers 4 to 8 inclusive need a sense of proportion, of lengths, and of angles, whilst Numbers 9 to 12 require ability to observe shapes and sizes. Number 13 calls for the smallest amount of manipulative skill; Number 14 for powers of observation and slight manipulative skill; and Number 15 is dependent on rapid observational power. Number 16 is as nearly as possible a test of simple touch, whilst Number 17 requires some observational power to distinguish the blanks, with or without milled edges, from the coins of the same diameters. Number 18 is again an almost elementary test of the sense of touch, but Numbers 19 and 20 call for a sense of weight. In Numbers 21 and 22, if the peculiar sense of touch is not very acute at first, it can very possibly be cultivated to some extent. Numbers 23 to 26 are possibly purely questions of habit and cultivation of the senses. Numbers 27, 28, and 29 are somewhat in the nature of puzzles, but power of observation, as in so many puzzles, is required to solve them. Numbers 30, 31, and 32 bring concentration, and to some extent memory, into play, and require observational power and a rapid sense stimulus. Number 33 is quite special, being a test of steadiness of hand. Numbers 34 to 38 are all tests of technical ability, and require special training. In connection with Number 38, it will be within the memory of many that during the war it was found to be possible to teach women to file flat in three weeks. Number 39 is a most valuable test, demonstrating the co-ordination of hand and eye. Number 40 is the only test of hearing that was

encountered. Number 41 is a most elaborate and comprehensive test, as will be gathered from the description of the apparatus.

THE TESTS AND THE APPARATUS EMPLOYED.

No. 1.—This consists of the ordinary test of power of vision, such as is used on the railways and for the Navy and mercantile marine.

No. 2.—This is the ordinary test for colour vision, and employs the methods laid down for the examination of engine drivers, &c.

No. 3.—An adjustable colour disc, giving a blend of two colours, is rotated by a motor. On the same axis a similar disc of about half the diameter of the larger one, can be declutched and stopped for adjustment, and again released and rotated synchronously with the larger. The candidate is required to adjust the smaller disc so as to match the larger.

No. 4.—A strip of wood, about 4ft. long and 3in. wide, is supported at an angle, by brackets at the back. Another strip of the same length, but only about half the width, is hinged to the bottom edge. When this narrower strip is folded up on to the wider strip, it conceals the markings of a half, thirds, quarters, fifths, &c. Metal cursors to hang on the top edge of the wider strip, are provided. The candidate is required to divide the length of the strip into so many equal parts.

No. 5.—A dial has a radial line painted on the face, extending vertically upwards, and one narrow arm pivoted at the centre. The other side of the dial carries a similar arm, and is marked with the correct angles. The candidate is required to place the movable arm at right angles, at 60 deg., at 45 deg., and at 30 deg. to the painted line.

No. 6.—A disc of opal glass forming the top of a cylindrical metal box, about 4in. in diameter, has two radial lines ruled on the upper surface, enclosing an angle of about 60 deg. Five thin metal radii are hinged to the centre and on top of the disc, and can be swung round through almost the entire circle. The metal casing encloses an electric lamp, and when this is switched on the correct divisions which are ruled on the under side of the disc can be seen. The candidate is required to bisect, trisect, or divide the complementary angle—about 300 deg.—into four, five or six equal parts.

No. 7.—A glass disc, about 1in. in diameter, has painted on the under side a circular patch about ¼in. in diameter. A black dot is painted on the upper side in the centre of the patch, which may or may not be in the centre of the disc. The candidate is required to place the patch in the centre of a circle of about 3in. in diameter. A pointer carried by an arm which swings up from the side indicates the position in which the disc should be placed.

No. 8.—A card has the ordinary diagram for noughts and crosses on it, the centre square being about 1½in. side. A vertical spike, supported by a light spring, slides through the hole in an arm overhanging a small platform. The candidate is required to place the card, whilst he is standing still in one position in front of the apparatus, so that when the spike is pushed down it will pierce the centre of the square.

No. 9.—Pieces of twisted square wire, both straight and bent, are mounted on a board. The candidate is required to point out similar pieces.

No. 10.—A shallow box about 20in. long by 10in. broad, has its lid in halves, one half being hinged to each of the long sides. When the lids are opened out the bottom of the box is seen to have seven rows, each containing fifteen screws wired to the bottom of the box. The screws vary in material, form of head, and in length from about 1½in. to ¾in., and in diameter from ¼in. to $\frac{1}{16}$in. Under each screw is a small hole, and the half lids have similar holes opposite to those in the bottom of the box, when the lids are closed. A specimen screw is fixed to the bottom of the box, above the others. The candidate is required to put a peg into the hole under every screw that he considers to be similar to the specimen screw. When the lids are closed, the holes that should contain pegs are seen to be marked.

No. 11.—Four double-ended spanners of different sizes, together with a collection of the corresponding eight different sizes of nuts and bolts, are laid on a table in front of a full-sized drawing of the four spanners on which is marked the bolt sizes of the spanners. The candidate is required to pick out any spanner and its corresponding nut, or bolt, as requested.

No. 12.—Three metal plates, about 4in. by 2½in. and ¼in. thick, have fine centre lines scribed on them. (*a*) has one hole, 0·78in. diameter, and one 0·82in. diameter, both drilled on the centre line; (*b*) has two holes of the same sizes as the above, but the larger of the two holes is drilled 0·03in. away from the centre line; (*c*) has two holes drilled in it, one 0·084in. diameter, the other 0·082in. diameter, the latter being drilled 0·015in. off the centre line. The candidate is required to point out the larger of the two holes in each plate, and to state which hole, if any, is out of centre.

No. 13.—A large shallow box has the bottom covered with marbles. The lid, when turned upside down and laid alongside the box, forms a tray with grooves running lengthways. The candidate is required to fill the tray with marbles, using both hands, and beginning at diagonally opposite corners.

No. 14.—The candidate is given a small coil of wire and a pair of cutting—only—pliers. He is required to reproduce with his fingers half a dozen simple specimen figures which are placed before him, mounted on a card.

No. 15.—Eight odd machine parts are fixed to the bottom of a box. The candidate is required, after 20 seconds inspection, to select eight similar pieces from a heap of parts, and to arrange them in a similar way in a similar box.

No. 16.—Four pieces of metal, or hardwood, are contained in a form of ballot box into which the candidate cannot see. Two of the pieces, all of which are about 4in. long and about 1¼in. in diameter, are of circular cross section. The other two are slightly elliptical. The sides of one of each pair of pieces are parallel, the other two being slightly tapered. The candidate is required to pick out, by feel only, the pieces asked for.

No. 17.—A collection of coins, say, half-crown, two shilling piece, shilling, sixpence, penny and half-penny is placed in a bag, together with a lot of blanks of the same diameters and thicknesses, with and without milled edges. The candidate is required to pick out the coins as asked for.

No. 18.—Eleven pieces of sheet metal all of different size, shape and weight, vary in thickness from 0·07in. to 0·01in. by differences of 0·007in. The candidate is required to arrange these pieces, by feel only, according to their thickness.

No. 19.—Ten metal cylinders, of exactly similar outside appearance, are drilled out at one end so as to be of different weights, the holes being plugged flush. The heaviest weighs 500 grammes = 17·637 oz., the lightest 365 grammes = 12·875 oz., the difference between contiguous weights being 15 grammes = 0·529 oz. The candidate is required to arrange the cylinders according to weight, the heaviest at one end of a row, and the lightest at the other.

No. 20.—Seven machine parts of very different form and size are placed before the candidate, who is required to pick out the heaviest. The pieces are all of exactly the same weight.

No. 21.—A plunger about 1in. in diameter, having (*a*) a flat, or (*b*) a convex, end, is moved by means of a screw up and down through a hole in a plane surface of about 2in. in diameter. A divided wheel on the screw reads by means of a vernier to 0·005in., the zero mark being the reading required, but the candidate cannot see the scale. The candidate is required to set (*a*) the two surfaces flush, or (*b*) set the top of the convex plunger level with the surface of the plane.

No. 22.—A needle point can be moved up and down inside a fine nozzle by means of a screw carrying a divided wheel, read by a vernier to 0·005in. The candidate is required to set, by feel, the needle point flush with the opening of the nozzle.

No. 23.—A stirrup-shaped handle can be pulled and/or twisted against springs, the amount of either process being recorded on dials which the candidate cannot see. The candidate is required to exert the same pull and/or twist two or three times.

No. 24.—The candidate is required to compress to the same extent two or three times an ordinary spring grip dynamometer arranged to record the effort exerted.

No. 25.—A small hand wheel on the end of a screw compresses a spring, and at the same time moves a pointer over a scale, which the candidate cannot see. The candidate is required to exert the same effort in compressing the spring two or three times.

No. 26.—The candidate is required to strike even blows with a hand hammer on a plunger restrained by a spring. The smallest movement of the plunger releases the escapement of clockwork which moves a paper on which the effort is recorded.

No. 27.—The candidate is required to assemble in twenty seconds six odd-shaped pieces which together form a cube.

No. 28.—A wooden block about 2½in. diameter has six pegs ¼in. diameter, and all of different lengths, projecting from one of its plane sides. Ten discs of thin fibre have holes punched in them. Only two of them can be threaded on the pegs. The candidate is required to thread as many as he can.

No. 29.—A metal disc about ¼in. diameter is drilled with seven holes, into four of which wires are fixed. The candidate is required to thread ten metal discs, all of which are drilled differently.

No. 30.—A motor-driven machine exhibits single numbers through a small window every few seconds. The candidate is required, as each fresh number appears, to repeat, in the order in which they appeared, the last three, four, five, or as many numbers as he can remember.

No. 31.—Groups of six letters are moved past a slit in a machine. The candidate is required to press a key, every time a particular letter is seen. A recording device shows how often that particular letter has been exhibited, together with the candidate's signal and time lag.

No. 32.—A machine has ten small windows in a row, under which white marks pass at irregular intervals. The candidate is required to press a key each time a mark passes. A recording device shows when each mark is exhibited, and when it is observed. Whilst undergoing this test the platform on which the candidate stands drops twice about ¼in.

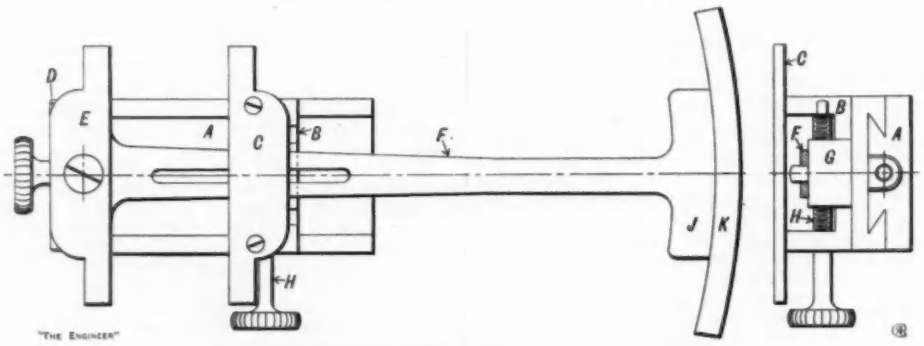

FIG. 1—APPARATUS FOR CALLIPERING TEST (No. 34)

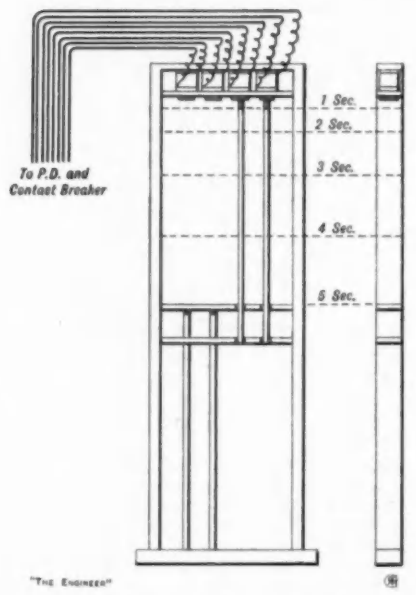

FIG. 2—DROPPING ROD TEST (No. 39)

No. 33.—A sheet of metal, about 12in. by 9in., has slots of the following shapes cut out of it:—S — I · M. There are three slots of each shape, the widest being 0·2in., the narrowest 0·14in., and the intermediate 0·17in. wide. The sheet of metal is connected through an electric bell and a paper recorder to one pole of a battery, the other pole of which is connected by a flexible cord to a metal rod 0·12in. in diameter, carrying an insulated handle. The candidate is required to place the metal rod in the slots, and, beginning with the widest, to follow the slot, as in freehand drawing, without making contact with the sides of the slots.

No. 34 (see Fig. 1)—On a bed A like that of a parallel vice there is mounted a movable head B, which carries on the top a strip of metal C, one edge of which—say, the right hand—is accurately normal to the slide of the bed. A fixed head D carries on a pivot a similar strip E, the other edge of which—say, the left hand—is the important one. This swivelling strip carries a long arm F, which is moved by a block G running on a screw H under the sliding head. By means of this screw the left-hand strip can be placed parallel with, or at an angle to, the right-hand strip. At the far end of the arm F is a vernier J, riding over a scale K graduated to read in thousandths of an inch out of parallel. When a test is being made the scale and vernier are covered. The left-hand strip having been set out of parallelism, the candidate is required to set the two strips parallel, using only a pair of ordinary outside callipers.

No. 35.—An accurately bored ring, about 5in. in internal diameter, ¾in. in radial thickness, and about ¾in. in depth, is fixed to a base plate. Three screws,

which may be of different length and pitch, pass radially through the ring at angles of 120 deg., points inwards. A ring about 3in. outside diameter lies on the base plate inside the larger ring, and can be moved by the three radial screws, so as to be about ¼in. excentric in any direction. Inside the smaller ring, which has a metal cover, is a system of levers moving a vernier over a scale, which shows to one-thousandth of an inch when the rings are concentric. The inner ring having been set out of centre, the candidate is required to set the two rings concentric, using only a pair of ordinary inside callipers.

No. 36.—A standard cylindrical plug gauge is clamped, by means of a screw, between two jaws, each of which embraces about nine-twentieths of the periphery, so as to give a nice working fit. The screw carries a divided disc, and is read to one-thousandth of an inch by a vernier, which the candidate cannot see. The candidate feels the fit of the plug in the jaws, and the jaws having been loosened is required to reproduce the same fit.

No. 37.—A compound slide rest having cranked handles, operated exactly as in a lathe, carries on the top slide a frame into which a card, about 6in. square, can be placed. The card has the section of an architectural moulding or some similar design printed on it. A pencil pressed down by a light spring is supported by an overhanging arm. The candidate is required to move the card under the pencil, using the handles of the slide rest as in turning, following the diagram as closely as possible.

No. 38.—A square block is mounted on a pin supported in a forked bearing. The stem of the fork is cylindrical, and fits into a base with a spring under it, so that the whole can be depressed. Levers connected to the block and to the fork make separate records on a drum worked by clockwork. The candidate is required to act as though filing the block quite flat, at the same time exerting the same pressure at each stroke, using a piece of smooth hard wood or metal, shaped like a file.

No. 39 (see Fig. 2).—A frame like that of a door is erected, about 8ft. 6in. high inside, and about 2ft. 6in. wide, the frame being about 6in. deep. Two planks are fixed across the frame inside, one about 4ft. from the top, the other at the same distance from the bottom. Four holes, about 1in. diameter, are bored through the top and vertically underneath through the two stretcher bars. At the top of the frame are four electro-magnets, or solenoids, each capable of supporting a light rod about 4ft. 6in. long, and about ⅞in. diameter, with a soft iron cap, one rod sliding up and down easily in each set of holes. A platform is provided so that the candidate's waist is a little above the upper stretcher bar. The bars can be released either by breaking the electric circuit by hand or by means of a motor-driven circuit breaker. The wall behind the frame is marked out in seconds, so that the examiner standing well behind the candidate can note the distance, or, rather, the time during, which a rod has fallen. The candidate is required to catch each bar as soon as possible after it has been released, and replace it in position at the top of the frame, where it is retained electrically. He may be required to use only one hand or both.

No. 40.—Sounds, as nearly as possible standard, are communicated over a telephone system. A variable induction is introduced between the microphone and the telephone. The candidate is required to repeat what he hears, to indicate the direction from which he hears it, or to take action on what he hears. In some cases attempts are made to distract his attention by giving instructions over the telephone while he is occupied with other duties, when he can press a key to show that he has heard, and take action when he has finished with that on which he is engaged.

No. 41 (see Fig. 3).—This, which the firm employing it calls its "driver's test," calls for a most elaborate piece of apparatus, which entirely occupies a shed about 40ft. long and about 18ft. or 20ft. wide. At the centre of one end is a platform A, 3ft. or 4ft. high, on which is a stool B for the candidate to sit on. On either hand are two levers C hinged to the floor in a position convenient for the candidate to grasp when seated. These levers, which can be moved backwards and forwards, operate switches communicating with recording devices. Down the left-hand side of the room is a model of a plate rolling mill D, about 6ft. between standards, with six or seven dummy live rolls in front of it. On either side of the roll housings there is a standard E, supporting a box 18in. square, with a coloured glass front, and electric lamps inside. On the ground close to these standards are two boxes F, about 18in. by 10in., with powerful white lights. On the live rolls are three boxes G, about 4ft. long and about 8in. square, the sides all being of red glass, and each containing several lamps. Arranged over the right-hand side of the room are about thirty metal lanterns H, some with red, some with green glass fronts. Numbers are painted on all these lamps, some being black figures on the coloured ground and others coloured figures on a black ground. The candidate, having taken his seat on the stool at the end of the room, is required to grasp one of the two levers on either side, one in each hand. He is told that he must keep a sharp look out, that whenever he sees a green lantern with an odd number on it lit up, or a red lantern with an even number, or it may be a red one with an odd number, or a green with an even number, he is required to pull one of the levers back smartly, push it forward again, and call out the number seen. He may be instructed to look out for one of any of these four groups, or to watch for any two groups, and will be told the appropriate lever to pull for each group. The room is then totally darkened, and a motor, which operates a drum carrying a series of contacts and a recording device, is started. The lights in the numbered lanterns flash up one at a time for a very short time and at very frequent intervals. At varying times one or other of the red hot ingots on the live rolls, the signal lamps on either side of the roll standards, and the two white lamps on the ground, which, although not actually dazzling, give out a considerable glare, are also flashed on and off. Further, on two occasions during the test, the seat on which the candidate is seated drops through about ½in., and as a culmination a good big spark gap is broken down just over his head. The moving of the levers closes a circuit which gives a record on a drum showing the time lag, and the correctness of the numbers is checked by the examiner watching the contact drum.

The following translation of part of a letter on this subject will be found of considerable interest.

PSYCHO-TECHNICAL LABORATORY.

I. *Present Sphere of Application of Psycho-technology.*

All classes of workmen, upon entry or transfer, are systematically put through a psycho-technical test, which, however, varies considerably in extent. In the majority of cases, we can make exact and reliable tests lasting two or three hours only in the most important kinds of work. In other cases we confine ourselves to a short general test, which is only meant to cover essentials. We, therefore, distinguish five groups of candidates:—(*a*) Unskilled workmen, transport workers; (*b*) Semi-skilled workers, foundry workers, &c.; (*c*) Drivers; (*d*) Skilled (special) workers; (*e*) Apprentices.

(*a*) *Unskilled Workmen, Transport Workers, &c.*

A short general test covers only the sense reactions and the simple physical functions.

(*b*) *Semi-skilled Workmen, Foundry Workers, &c.*

In addition to the (*a*) standard, a certain technical or practical intelligence is required. Powers of observation and reaction to stimuli also gain in importance. Several of the trades which come under this heading have to undergo a detailed test.

(*c*) *Drivers.*

Candidates in this group really come under the heading of semi-skilled workers. On account of the very high responsibility of these men, crane operators, drivers of rolling mills, attendants on motors operating shafting, switchboard attendants, &c., they are submitted to a searching test, which in the case of crane drivers consists of the following:—

1. *Pure Sense Reaction Test.*

Sight.—Keenness and colour reaction, according to Snellen and Stilling's tables.

Hearing.—With our own ear tester, in which the tone of a telephone is altered by varying the induction connection between the telephone and microphone circuits.

Sense of Touch.—Two surfaces must be brought with the fingers only to exactly the same level.

Freedom from Giddiness.

2. *Indirect Sense Reactions.*

Observation and Concentration.—The candidate is subjected to various light stimuli, and has to react to them by making certain movements with levers and by calling out the figures.

Localisation of Sounds.—The candidate has to indicate the position of various sound stimuli.

Hand Flexibility, &c.—Ability is tested to work with both hands at the same time.

Reaction.—Bars, suddenly released from magnets, have to be caught as quickly as possible by the candidate. The height of drop, converted into time, gives the speed of the hand reaction.

Strength of Nerves.—During a long test demanding great concentration, the candidate is submitted to unexpected shocks, flashlights, noises, &c.

Depth Judging.—From a platform, 8 m. high, the candidate has to lift balls through a certain height.

Technical and Practical Ability is tested with models, drawings, technical problems, &c.

(*d*) *Skilled (Special) Workers.*

These men have already chosen their trade. A suitability test would have no object in this case. In its place there is a knowledge test, drawn up on a psycho-technical basis, which deals with machines, tools, material, methods of work, reading drawings, &c.

(*e*) *Apprentices,* as future skilled workers, have to undergo a thorough suitability test and are allotted trades on the results. Their test is along the same lines as that for crane drivers.

II. *Prevention of Accidents.*

The suitability tests find, in addition, a very wide field of application in the problem of the prevention of accidents. Here, again, the psycho-technical laboratory forms the centre. We endeavour, in the prevention of accidents, to work in two main directions, viz.:—

(*a*) General prevention by means of explanations, propaganda by means of pictures, and organisation of first-aid service in the works.

(*b*) Individual prevention. Every man injured by an accident must report for statistical purposes to the laboratory before he is allowed to recommence work, and must then undergo a test to determine whether any physical or psychological defects have to be taken into account as causes of the accident.

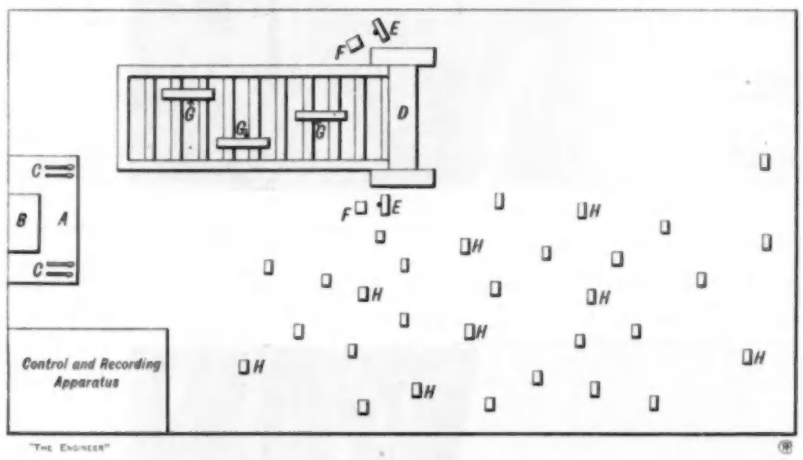

FIG. 3—THE "DRIVER'S TEST" (NO. 41)

In cases in which the results of the test show that no further responsibility for the man's safety can be undertaken, the man is either transferred to less dangerous work or dismissed.

III. *Conducting and Marking of the Tests.*

The result of every test is expressed in figures on the basis of which, from specially drawn curves, percentages are obtained which are arranged according to the individual spheres of ability and are united to form general ability curves—characteristic curves. The candidate's work is allotted on the basis of these curves.

IV. *Results.*

The psycho-technical suitability tests, especially those for the apprentices and the drivers, can be regarded as having sufficiently proved their worth. On the basis of extensive statistical comparisons an accuracy of 83 per cent. is shown in our apprentices' test.

For the drivers' test, the accuracy may be still greater, but in this case it is very difficult to set up a standard. All the same, it is worthy of note that crane accidents have diminished very appreciably since the introduction of the drivers' test.

LEAKAGE of outside air into the gasbags of airships occurs with helium as with hydrogen, but the mixture in the former case is non-explosive, and recent methods developed in the United States (Bureau of Mines) enable the helium to be re-purified. In one case activated charcoal cooled to −120 deg. Cent. in liquid air absorbs the nitrogen and oxygen, but leaves the helium, and is re-activated for further use by warming and exhaustion. In the other, the oxygen and nitrogen are removed by liquefaction under 1800 lb. pressure in liquid air. The latter method is cheapest and the cost amounts to less than 6s. per 1000 cubic feet. This is very small compared with the expense of the usual re-inflation, ten times a year, with hydrogen.

THE GRAMPIAN HYDRO-ELECTRIC POWER SCHEME

BALFOUR, BEATTY AND CO., LTD., LONDON, ENGINEERS AND CONTRACTORS

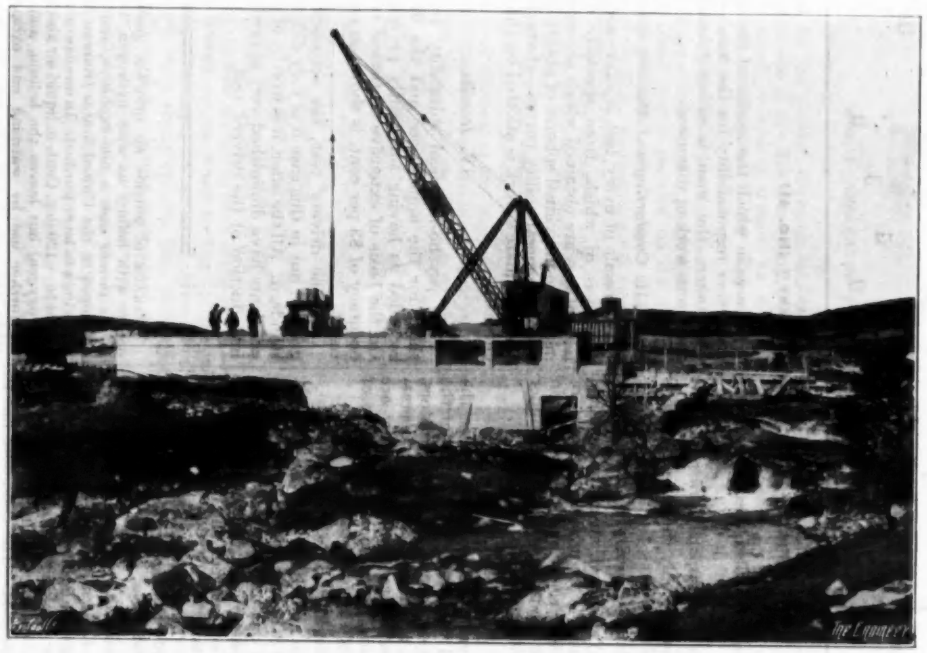

FIG. 15—ALLT GHLAS DAM DURING CONSTRUCTION

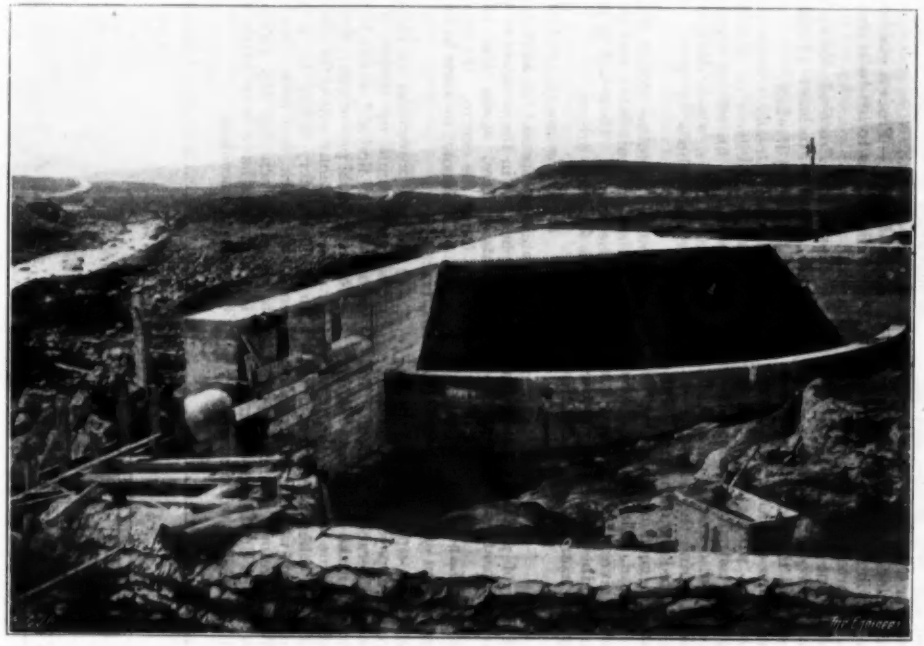

FIG. 16—ALLT GHLAS DAM—SCREEN AT HEAD OF AQUEDUCT

FIG. 17—MHEUGAIDH DAM—UPSTREAM FACE AND SCREEN

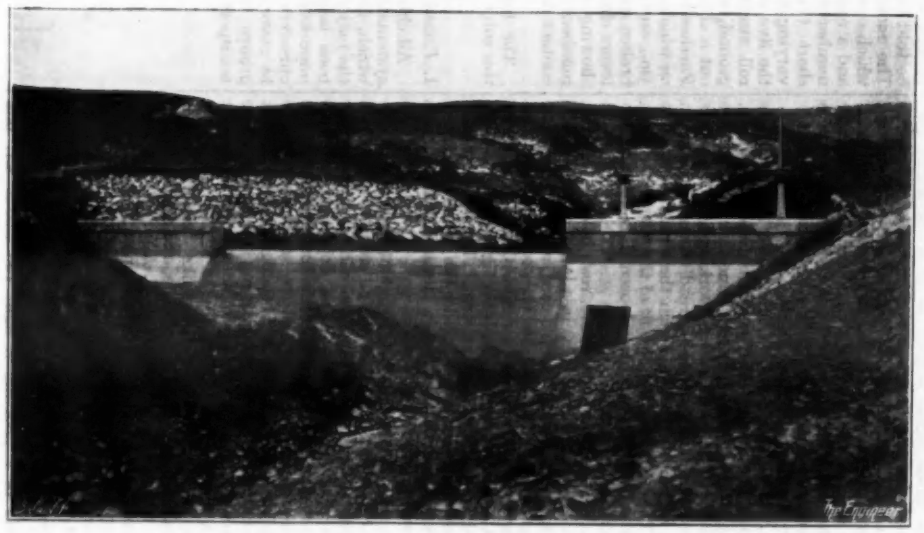

FIG. 18—MHEUGAIDH DAM—DOWNSTREAM FACE AND SPILLWAY

The Grampian Hydro-Electric Power Scheme.

No. III.*

ALLT GHLAS.

A STREAM, known as the Allt Ghlas, joined the River Ericht at a point just below the site of the dam. The declivity of this stream was such that its flow could readily be diverted into the Loch Ericht reservoir by the construction of a dam at a point not very far upstream from its confluence with the Ericht. At the site chosen solid granite outcropped on the surface, and it was not difficult or expensive to secure a satisfactory foundation. The dam, which is of concrete and of the gravity type—see Fig. 15, page 190—is 240ft. long and it rises to a height of 17ft. above the bed of the stream. It was formed in two sections, half the bed of the stream at a time being dammed off by means of sand bags. The dam is furnished with an intake chamber, protected by a screen—see Fig. 16, page 190—to catch floating matter, and arranged with an intake sluice, 7ft. by 5ft. For the discharge of silt from the dam there is a scour sluice measuring 5ft. square, and a draining scour valve 12in. in diameter. The aqueduct leading the diverted water into the Loch is a rectangular channel, 7ft. wide and 4ft. 6in. deep. It is formed of reinforced concrete and is 1618ft. long. It is not quite straight, as it follows the contour of the land and it enters the Loch or reservoir by passing under the east wing wall of the main dam and along an inclined channel formed against the upstream side of the dam and furnished with a "jump" at the bottom to break up the flow.

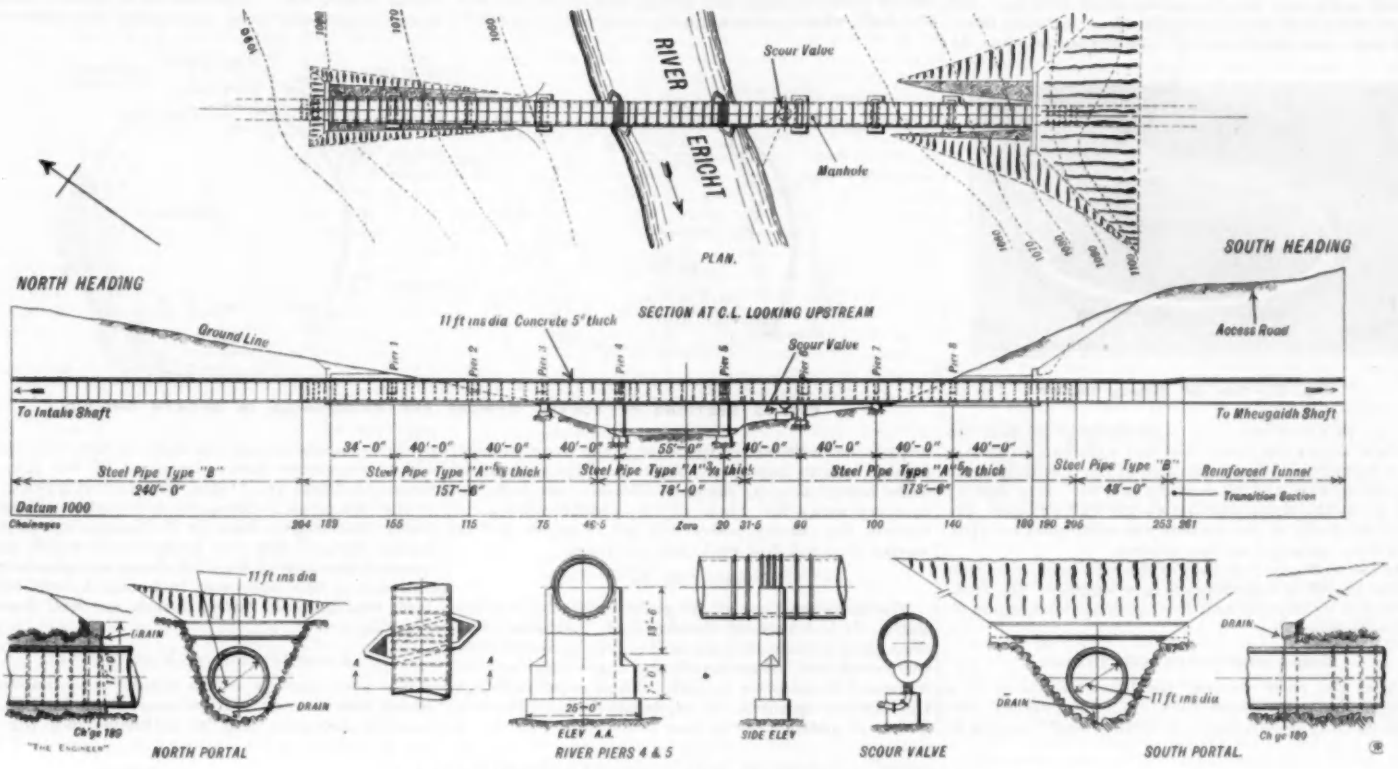

FIG. 19—PLAN, PROFILE AND DETAILS OF RIVER CROSSING

MAIN TUNNEL.

We can now proceed to describe the tunnel which was driven to convey the water from the loch to the power-house, and which embodies several interesting features. As shown in Fig. 2 *ante*, the intake shaft is not opposite the spillway portion of the dam, but is to the westward of it. In order that the tunnel might be in solid rock it was driven in a straight line and at a considerable angle with the centre line of the dam for a distance of 320ft. from the intake shaft to a point downstream of and just past the western end of the core wall section of the dam. There, the tunnel makes a slight bend to the southward and then continues in a straight line for 907ft., where there is another bend, again slightly to the southward. From the intake shaft to this point, a distance of 1227ft. 6in., the gradient of the tunnel is 1 in 620·5.

The arrangements at the foot of the intake tower and between that point and the entrance to the standard section of the tunnel were shown in Fig. 10 *ante*. It will be remembered that the dimensions of the emergency roller gate were 15ft. high by 8ft. wide. As the tunnel proper is of horseshoe section with a maximum width of 12ft. 2½in., it was necessary that there should be a transformation section between the gate and the tunnel inlet. The transformation section has a length of 18ft. 6in., and the alteration in cross section is brought about in six stages, as may be seen from the drawing, which is so clear as to need no further explanation. The drawing also shows the method of reinforcement employed. There is an air vent 4ft. by 2ft. 6in., taken upwards from the roof of the tunnel to the atmosphere. The lining of the tunnel throughout, including that of the intake chamber and transformation section, is of 1 to 2 to 4 Ciment Fondu concrete.

From the second bend, 1227ft. 6in. from the intake shaft, the tunnel is taken in a direct line to the surge shaft above the power-house, a distance of just over 12,070ft., with a gradient of 1 in 294 for the first 7550ft. and of 1 in 290·4 for the remainder. On the way a series of hills is passed under, the highest of which are Sron Bheag and Meall Gorm, the latter having a height of 1719ft., so that its summit is some 700ft. above the tunnel.

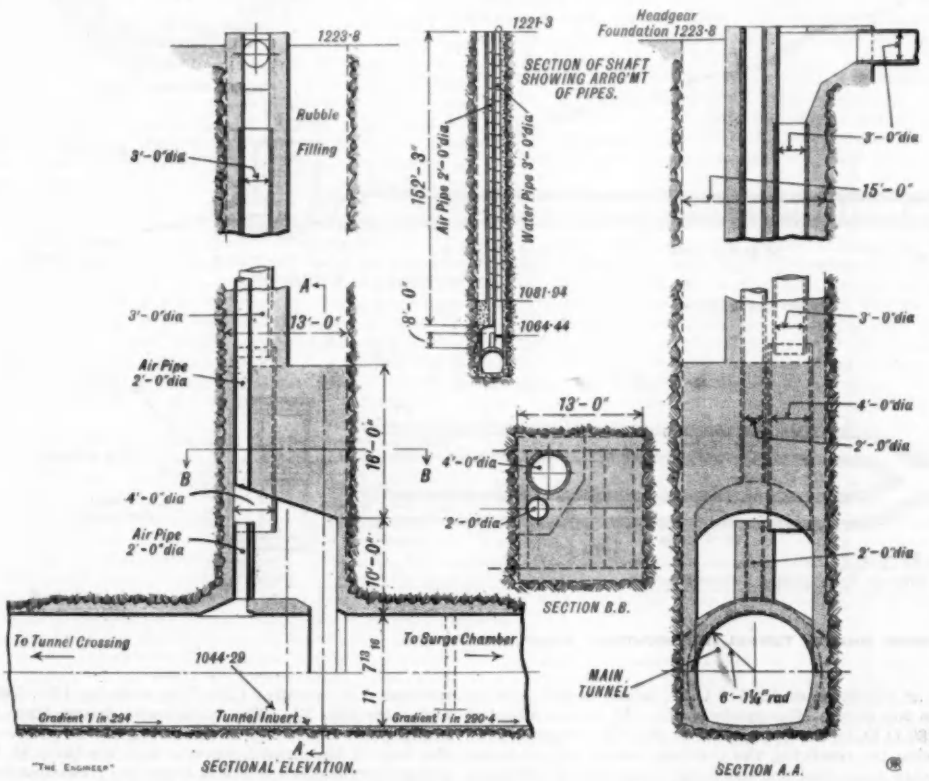

FIG. 20—ARRANGEMENT OF MHEUGAIDH SHAFT

TUNNEL CROSSING.

The tunnel is not wholly in rock, for at a distance of 2650ft. from the second bend the River Ericht is encountered. In that portion, the tunnel consists of riveted steel pipes, supplied by the South Durham Iron and Steel Company, Ltd., which are taken across the river at an angle of 75 deg. with the axis of the river bed with their undersides about 15ft. above the water—see page 196. The actual length of pipe line in the open is some 275ft., but the pipes are continued, on both sides, into the hill for a length, on the north side, of over 300ft. and on the south side of just over 100ft. The arrangement is shown in Fig. 19. In the open the pipe is carried on eight concrete piers of varying heights spaced mostly at 40ft. centres, except in the river crossing, where the two piers, erected on foundations sunk in the river bed, are at 55ft. centres. The pipes are lined throughout with concrete 5in. thick and have a diameter inside the concrete of 11ft. They are of two types, known as A and B, and are of double riveted mild steel plates, those of type A being ⅝in. and ¾in. thick, while those of type B are ½in. thick, the thicker pipes coming where the river is crossed. At intervals apart of 72in. the pipes are strengthened by external L rings riveted to the plates. On both sides, where the rock of the hillside is entered, additional L rings are employed so as to give greater strength. Additional L rings are also put on where the pipes rest on the piers. The total length of the pipe line is just under 700ft., and throughout it is laid

* No. II. appeared August 14th.

on a downward gradient of 1 in 294. On the underside of the pipe on the south bank of the stream there is a 3ft. radius dome sump, to the bottom of which is attached a 15in. diameter scour valve and jet disperser, through which water may, when required, be discharged into the River Ericht. The whole arrangement of this river crossing and of the north and south headings into the hillside are so well shown in Fig. 19 that no further description than the foregoing appears to be necessary.

For the steel lining of the tunnels on each side of the river crossing the pipes were sent in sections—two to the circle—but for the pipes between the portals—that is to say, for the actual river crossing—the plates were delivered in smaller sizes, suitably bent, and were assembled, riveted and erected at site. At

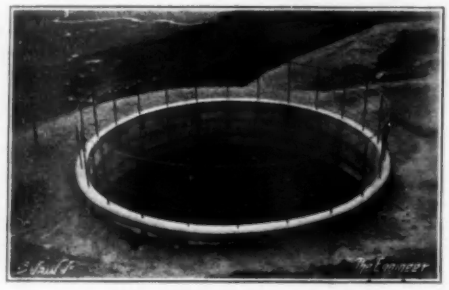

FIG. 21—TOP OF SURGE SHAFT

various points in the tunnel, particularly (*a*) near the portals, where the cover was not sufficient to give a good support; (*b*) on both sides of the openings made to join up with the Mheugaidh and the surge shafts; and (*c*) at the sump just before the valve house—the concrete lining of the tunnels was reinforced by 1¼in. steel bars arranged at 6in. centres.

At the west and east ends of the pipe line the section of the tunnel is transformed in a length of 8ft. from horseshoe to circular and from circular back again to the horseshoe.

Mheugaidh Shaft and Intake.

From the river crossing the tunnel is taken in a straight line to the surge shaft. At a point rather more than halfway in this length a vertical shaft, known as the Mheugaidh shaft, descends into the tunnel. This shaft, which is for the purpose of delivering the waters of the Mheugaidh stream into the tunnel, is just over 154ft. deep to the tunnel and is oblong in cross section, measuring 15ft. by 13ft. The two vertical pipes—3ft. for water and 2ft. for air—which are of concrete, were run side by side embedded from top to bottom in 1 : 4 : 8 concrete in one corner of the excavation. At the bottom of the 3ft. diameter water pipe the diameter for a length of 17ft. 6in. was increased to 4ft. The arrangements are well shown in Fig. 20. There is a short length of 2ft. diameter air pipe, which terminates at the bottom in an air catch pocket, and is run upwards from the top of the tunnel into the chamber of the water down pipe, its centre coinciding with the centre of the 2ft. diameter air pipe running up to the atmosphere so that any air brought down the tunnel may escape up it.

To divert the waters of the stream a gravity section concrete dam 65ft. long has been constructed—see Figs. 17 and 18, page 190. It, like the Allt Ghlas Dam, is furnished, on a smaller scale, with an intake chamber provided with screens, and has an intake sluice 4ft. in diameter and a scour sluice measuring 3ft. square. The discharge from the intake chamber is conveyed in a line 525ft. in length of circular reinforced concrete pipes, 3ft. in diameter, to the head of the shaft, which stands at an elevation of 1225·12 O.D. at an elevation of 1225·0 O.D., which is the same as the top of the Mheugaidh shaft. At an elevation of 1180 O.D. in the upper part of the shaft there is provision for receiving the conduit, which will at some future time lead the discharge from the Killichonan Burn and other streams into the tunnel, as explained in the first part of this article.

At a point about 385ft. beyond the surge shaft the tunnel bifurcates—see Fig. 22—and the cross section of the tunnel is altered from one of horseshoe shape to two circular pipes, each of 10ft. 6in. internal diameter, and this construction is continued to behind the valve house, the total length from the foot of the surge shaft to the far end of the pipe line in the valve house being just over 720ft. Behind the valve house there is a sump to arrest any heavy foreign matter which may, in spite of the provision of screens, &c., find its way down the tunnel. Up to that point the linings of the twin tunnels are formed for the greater part of the length of steel pipe with an outside diameter of 11ft. 4⅞in. in 6ft. lengths. The sump is formed of two lengths of semi-circular plates bent to an inside radius, with their concrete lining, of 5ft. 3in., these two plates being separated by two vertical straight plates 4ft. deep, the effect being that the sump is of the form of an oblong with a greater diameter of 14ft. 6in. From the lower part of this sump a valve-controlled scour pipe is led to a culvert, 6ft.

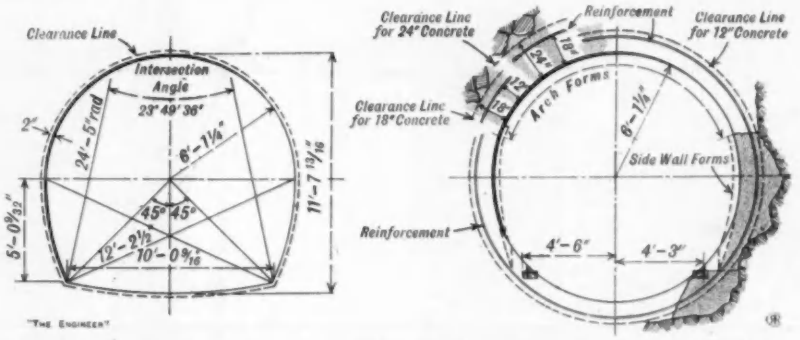

FIG. 23—SECTIONS OF TUNNEL—TYPICAL AND RE-INFORCED IN BROKEN GROUND

or just over 60ft. above the level of the water in Loch Ericht. If at any time, therefore, the amount of water being taken by the power-house is not sufficient to carry away the whole of the discharge from the stream, the surplus water will not overflow and be wasted, but will flow back into the Loch.

Surge Shaft.

The surge shaft comes at a point 4508ft. beyond this shaft. It is a vertical circular shaft just over 196ft. deep sunk in the solid rock, and is 12ft. in diameter for the lowest 70ft. of its depth, the upper portion being increased in diameter to 45ft. It was excavated from the bottom upwards, as explained later. The top, which is guarded by a deer fence—see Fig. 21—is

Construction of Main Tunnel.

The general shape of the horseshoe section tunnel, which has a cross section equivalent to 12ft. 4in. internal diameter, will be gathered from the illustrations. It measures 12ft. 2½in. wide by 11ft. 7 13/16in. high—see Fig. 23. The tunnel was driven from six headings as follows:—One heading at the intake at the foot of the intake tower; two headings at the point where the River Ericht is crossed; two headings running in opposite directions from the Mheugaidh shaft; and one heading at the outlet portal.

The triangulation for the tunnel was based on the Ordnance Survey. Three Ordnance Survey stations were used, with permission of the Ordnance Survey Department, and from them the lengths of the three sides and the dimensions of the three angles were also obtained. Using this information as a basis, the

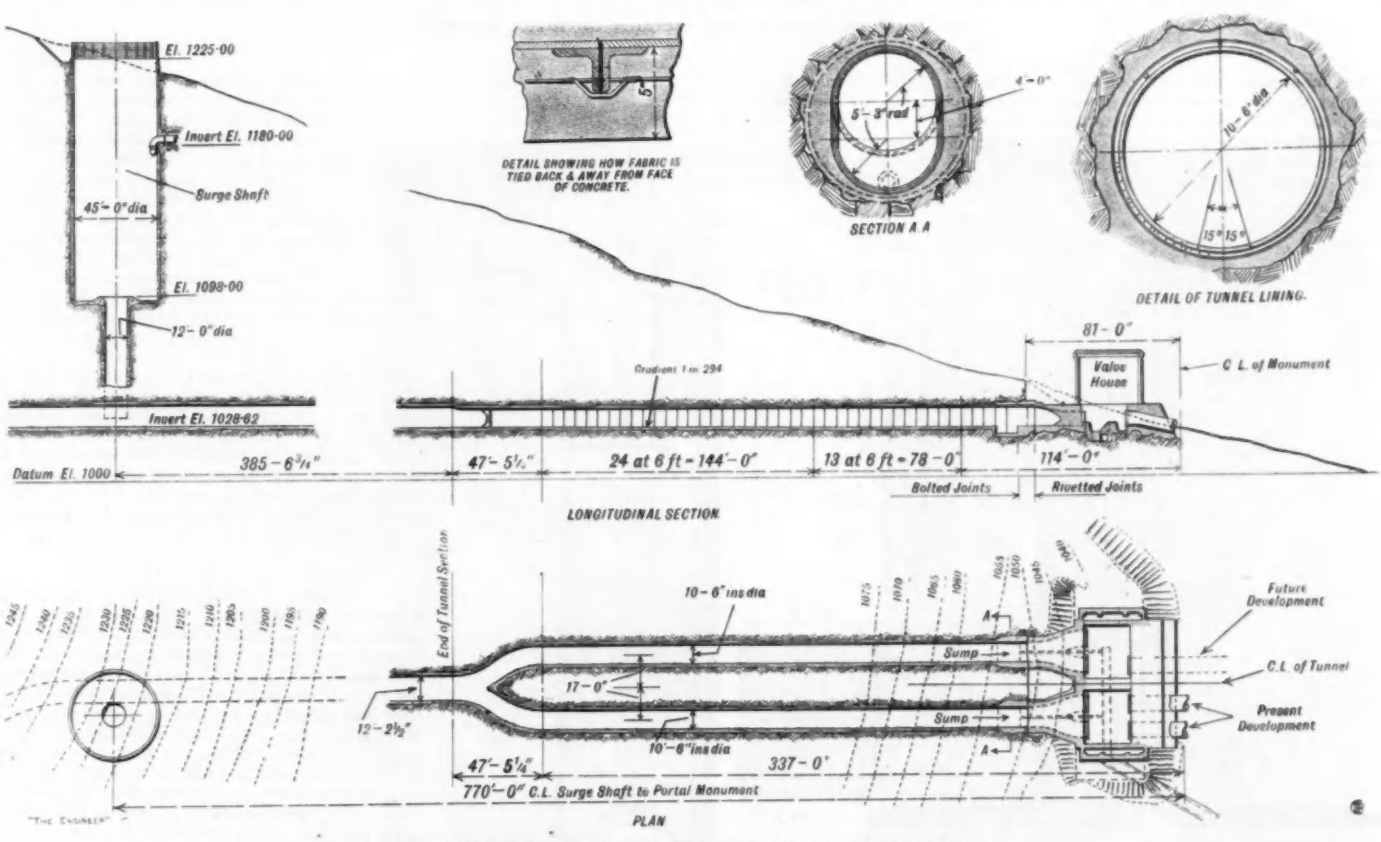

FIG. 22—SURGE SHAFT, TUNNEL BIFURCATION, SUMP AND PORTAL

triangulation for the tunnel was carried out without the necessity to measure an accurate base line. The survey work was so accurate that all the headings met correct for line and level.

The excavation was effected by means of compressed air drills, a pressure of 100 lb. per square inch being employed. The air compressors were of the totally enclosed two-stage type and were electrically driven, each of a capacity of 750 cubic feet of free air per minute, and were stationed at the mouth of each heading. These compressors were made by Alley and MacLellan, Ltd. There was also one P.O.C. direct-connected oil engine air compressor of 100 H.P. and 608 cubic feet piston displacement, made by the Ingersoll-Rand Company. The ventilation of the tunnel during drilling and blasting was effected by fans and by 15in. diameter pipes to the headings. Very little water was met with during the driving of the tunnel.

The material traversed consisted of granite from the intake to the Mheugaidh shaft, that for the remainder of the length being banded flaggy gneiss. The explosive used was 60 per cent. N.G. gelignite. The work was continuous day and night. The work of lining was carried out while the excavation was in progress, the lining gangs being kept about 400ft. from the working faces. The lining was done in three sections; first, the sides, then the roof, and then the invert, steel forms on travelling carriages being used, much in the same way as for the Lochaber Tunnel. In our walk through some 2 miles of the tunnel we had occasion to observe how well the lining had been carried out and how smooth the surface was throughout. The lining was of Ciment Fondu concrete, the mixture being 1 : 2 : 4. The sand employed was obtained locally and the stone for the aggregate consisted of crushed rock excavated from the tunnel.

Surge Shaft.

The surge shaft was constructed by running, first of all, a small stope from the tunnel up to the surface, a distance of 192ft. The remainder of the excavation was then carried out from the top of the shaft downwards, the excavated material being dumped down the small stope and caught at the bottom in a rough hopper, from which it was loaded into wagons and taken out to the tip at the portal. The surge shaft was lined throughout with concrete to the finished diameters given above. The concrete was placed behind steel shutters carried on a braced steel tower, the forms, when the concrete had set, being moved back from the surface and raised by pulleys in 4ft. lifts.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

RAILWAY ELECTRIFICATION.

Sir,—There has recently been much discussion about the electrification of the railways, *i.e.*, about the centralisation of the production of energy for moving trains. This idea is not so new as it seems; it is older than the railways themselves. It was introduced by Edgeworth and discussed by the Society of Arts in 1768. Against this idea George Stephenson fought all his life. Even as late as the beginning of 1829, when the Liverpool and Manchester Railway was nearly completed, the question of traction for it had not been decided. Although George Stephenson was the chief engineer, the majority of the directors were in favour of horse traction. In order to decide this question the opinions of the two foremost British engineers of the time, Walker and Rastrick, were sought. They were in favour of steam power, but only on condition that it was produced, not on locomotives, but at central power plants. According to their design these power plants were to be placed at 1½ to 2 miles from each other all along the line. Steam engines on these plants were to operate continuous cables to which the wagons were to be attached. The success of the "Rocket," however, vindicated the idea of the locomotive, *i.e.*, an engine embodying an independent source of motive power. In 1841, nevertheless, Brunel came forward with the idea of "atmospheric" railways. This idea consisted of having a pipe running the whole length of the railway and of producing a partial vacuum in this pipe by means of pumps at central power plants.

Electricity has, of course, made Edgeworth's idea more applicable; but in the last thirty years locomotives have also undergone a great deal of development. In the last ten years this development has affected not only the details, but also the fundamental principles of locomotive design. This refers to high-pressure locomotives, turbo-locomotives and Diesel-locomotives. The two former types have already reached the overall efficiency of electric traction—12 to 13 per cent.—while Diesel-locomotives have already attained 24 to 27 per cent. It seems to me, therefore, that the locomotive and the centralised power station are in approximately the same relation to each other as they were a hundred years ago. Further advance in engineering cannot be foreseen. It can take the direction of either the locomotive or the power-house, giving whichever is adopted temporary advantages.

Locomotive traction, however, will always have certain inherent advantages: (1) Locomotives can be transported from one place to another, and even from one country to another. As a consequence of this facility, when there is a sudden and temporary increase in the traffic of any given district, supplementary motive power can quickly be sent to that district and equally quickly removed again when it is no longer required. With central power plants this possibility does not exist, and the plants must be designed to suit maximum traffic, which only seldom occurs. (2) Electrification approximately trebles the capital irretrievably buried in a given place. According to the most recent data of the Swiss, Austrian, German, French and Brazilian railways, the cost of electromotives is only 18 per cent. of the total cost of electrification, the cost of the wiring and sub-stations being 40 per cent., and that of the central power plants 42 per cent. This makes electrified railways much more conservative in adopting improvements in motive power than railways using locomotives. New types of locomotives can work together with old types and the economy of each locomotive of a new type starts immediately. It can be thoroughly tested before being produced in quantity. The effects of electrification become apparent only when the whole scheme is completed for a given district and at the same time that district becomes closed to locomotives. Any improvements in central plants are much more difficult to realise than in separate locomotives.

From the above it becomes clear that the general electrification of all the railways will preclude the possibility of testing and utilising new developments in locomotive traction and make the railways less adaptable to the varying traffic conditions. Both these considerations do not, of course, apply to the partial electrification of certain districts through which locomotives could pass if necessary. The electrification of suburban railways, for instance, meets with no objections.

In conclusion, I should like to say that the word "*loco*motive" means an engine embodying an independent source of energy. An electromotive, therefore, receiving its energy from a central power plant is not a locomotive.

Cambridge, August 12th. G. Lomonosoff.

RAILWAYS AND THE PUBLIC.

Sir,—I was very interested in a letter headed "Railways and the Public" in your issue of July 31st. Your correspondent is perfectly right in his statement that the railways should run shorter trains at frequent intervals if they wish to compete with road transport. My own view is that the great weight of railway passenger rolling stock makes it impossible to run the sort of service the public requires at fares which passengers will pay. The remedy is to re-design passenger vehicles somewhat on the following lines:—Light pressed steel wheels; alloy steel axles, which could be very much lighter than the present ones; live axles are probably unnecessary; self-lubricating roller bearings might be suitable; the underframes or chassis could be vastly reduced in weight if the wheel base were shortened and the top hamper lightened.

The new design should be undertaken without regard to previous railway practice, the experience of motor engineers and motor coach body-builders being drawn on. It should be possible to design rolling stock lighter than motor coaches, as the latter incorporate power units, gear-boxes and transmission, while a railway carriage is only a trailer.

The saving in fuel or electric energy would be in proportion to the reduction in weight. Other advantages would be less wear and tear of permanent way, a reduction of noise, better acceleration and increased comfort.

London, August 14th. Debenture.

THE EFFICIENCY OF KEARSLEY.

Sir,—Your articles on the results obtained at the Kearsley power station have been of great interest. There can be no question of the credit they reflect on all connected with the design and operation of the station. But there is a note of complacency running through your comments which, I submit, is dangerous. At Kearsley results have been achieved surpassing those of stations working on cycles which are thermo-dynamically superior, but one demurs at the implication that the more progressive designs thereby stand condemned. May not one reasonably hold that the standard of perfection reached under the conditions used at Kearsley indicates that further improvements can only be hoped for as a result of the adoption of more efficient thermo-dynamic conditions? That in the development stages mechanical difficulties tending to nullify any gain may often be met with is true, but that is no reason for standing still. Our future is hopeless if we once become content that all progressive design should be the work of the engineers of other countries.

I suggest that your statement that steam at Kearsley is looked upon as far too valuable to be used for anything but the generation of power in the main turbines is liable to misconstruction, in that it is described as a principle instead of as a policy which may be correct for certain conditions. Surely one can take it as axiomatic that steam should only be used for any purpose when an overall economy results from doing so. The alternatives are assessable, and full inquiries into costs will often lead to decisions the reverse of those taken at Kearsley.

One doubts if the influence of load factor can be summarily dismissed. It is true that the figure for the average load factor may mean little, but the actual shape of the load curve is significant. Are not the sharp and sometimes variable peaks of a lighting and traction load more inimical to the maintenance of economical running conditions than the more accurately forecasted "tablelands" of an industrial load curve, though the average load factor be the same in both cases?

R. H. Dibb.

Stockton-on-Tees, August 11th.

[As consistent advocates of high steam pressures and temperatures and of every improvement in thermodynamic cycles, we regard the Kearsley results rather as an incentive to good design than as a condemnation of more advanced steam conditions. As soon as a station is designed so as to combine a theoretically superior heat cycle with the same regard to practical operating conditions that distinguishes Kearsley, then it will show an even higher efficiency. With regard to the influence of load factor, the Parsons Line shows that, within the limits of commercial accuracy, the total fuel consumption of any power station over a given period of time is a linear function of the electrical output during that period. Hence to every output there corresponds a definite fuel consumption, independently of whether the load was regular or not during the period. The analogous Willans Law proves, similarly, that if a steam turbine develops 10,000 kWh in ten hours, it is immaterial, so far as steam consumption is concerned, whether it runs idle for a portion of the time, or whether it runs steadily on a load of 1000 kilowatts.—Ed. The E.]

STRESSES IN HELICAL SPRINGS.

Sir,—Having been vividly interested in Mr. L. E. Adams's article on "Helical Springs," printed in The Engineer of June 26th, 1931, I undertook the integration of the two double integrals given in the article for the evaluation of the values of x and K, the detailed integration not having been reproduced in the printed article. I used for the first of the two integrals the same method as for the second one—the latter being more complicated—and came to the same result for x as Mr. Adams, only that Mr. Adams's expression for x in formula (2) can be brought into a form more simple for the purpose of numerical evaluation.

As for the second integral, giving the value of K, my calculation led me to a result, whose algebraic expression is essentially different from that of Mr. Adams's formulas (4) and (4 a). Nevertheless, the fact that the numerical values of K, for two values of $c=d/D$, to which I came, are pretty close to those of Mr. Adams, makes me suppose that Mr. Adams's error in the process of integration, if any, has been very slight, or that he used some approximate method of integration—as, for example, an infinite series or similar method. In the latter case, the method of integration which I used would make the solution more simple and exact.

Of course, the possibility still remains that my results are erroneous, and that Mr. Adams's are correct. Herewith are attached my calculations, which I submit to your and to Mr. Adams's judgment.

Needless to say, that in any case a slight error in the calculation would not affect in any way the high scientific value of Mr. Adams's interesting and original contribution to the theory of helical springs with circular section.

Jacob Bromberg.

Tompkinsville, S.I., N.Y., July 30th.

Sir,—I thank you for letting me see Mr. Bromberg's letter and the mathematical workings accompanying it. I have examined Mr. Bromberg's solution and find it quite correct.

The difference in the algebraic form of the two expressions for the function K is explained by the fact that Mr. Bromberg integrated first with respect to w and then with respect to r, whereas I reversed these operations. The integrations involved are simpler when Mr. Bromberg's method is adopted, but the result given by equation (4) of my article is exact; it was not obtained by approximate methods of integration. The slight differences in the values of K, calculated by Mr. Bromberg—amounting to less than 0·054 per cent. when $c=1/3$ and less than 0·31 per cent. when $c=1/10$—are due to my use of the irrational quantity x in determining K, and show clearly that the two expressions represent the same quantity. The effect of the slight error in the values of K, given in my table, will be inappreciable in the value of C_R, and particularly so when it is remembered that the constant C_1 in equation (7) is known only approximately, unless the various stresses be combined in each individual case.

Mr. Bromberg's values, viz.:

$$K=\frac{d^2}{2}\left(x-\frac{D}{6}\sqrt{1-c^2}\right)-\left\{D\,x\,(D-x)-\frac{D^2}{6}\right\}(1-\sqrt{1-c^2})$$

which, on eliminating the quantity x, reduces to:

$$K=\frac{D^3}{48}\left[2\,c^3-(4-7\,c^2)\,(1-\sqrt{1-c^2})\right]$$

are worthy of publication, since they render the practical application of the formulæ (5) and (7) of my article easier.

I am indebted to Mr. Bromberg for these simplified results, and have to thank him for his expression as to the value of my contribution to the theory of springs.

Stockport, August 13th. L. E. Adams.

The Great Western Railway, in a statement issued on August 18th, claims, as the result of the overhauling of its services, to be in a position to offer the fastest goods service ever provided for the conveyance of all types of merchandise. Forty-three examples given represent a net saving of over 122 hours daily, ranging from 40 minutes to 6 hours 20 minutes.

High-Tension Testing Equipment.

As far back as the early days of the industrial application of H.T. current, the Oerlikon Company began to manufacture testing plant for testing insulation and cables at high pressures, and since that time it has acquired much valuable experience in this connection. The principal part of these equipments is, of course, the transformer or transformers, which present special insulation problems. According to the output and pressure required and the mode of connection adopted, this part of the equipment consists of a single transformer giving the total pressure required on the secondary side or several cascade connected transformers.

While the question of the shape of the pressure wave may be of secondary importance in the case of tests of short

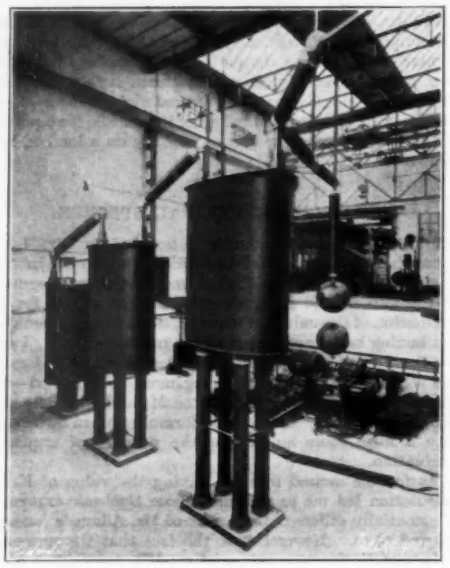

FIG. 1—MILLION VOLT TESTING EQUIPMENT

duration, this is no longer true in the case of prolonged tests such as those on cables. Under these conditions it is necessary to have on the secondary or H.T. side a wave as near as possible a sine curve, and it is essential to eliminate all causes which may lead to the deformation of the wave. The testing plant should not be connected directly to the distribution system, as the pressure wave of the system may differ considerably from a sine curve. The pressure curve may also be subjected to deformations when sudden switching operations occur in the system. Experience also shows that owing to magnetic saturation and to the presence of teeth in induction regulators, this apparatus also interferes with the wave form, and the supply must therefore be derived from an alternator

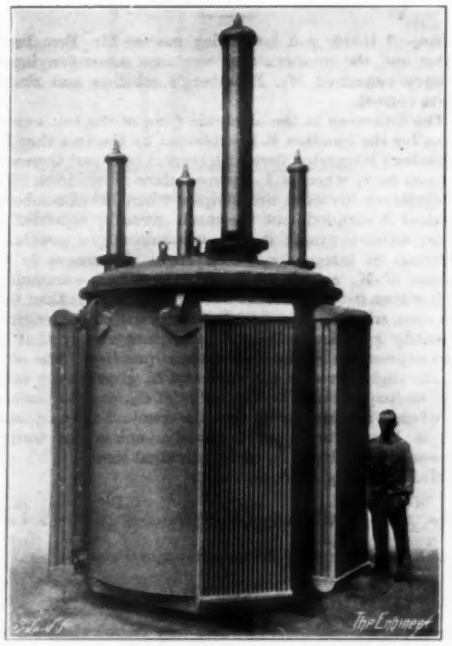

FIG. 2—200,000 VOLT TRANSFORMER

producing a perfect sinusoidal curve, whilst as regards the transformer the influence of its saturation on the pressure wave is reduced as far as possible by limiting its value. Alternators with salient poles can only give satisfaction within restricted limits, and for that reason it is not considered advisable to use them. Even when use is made of liberally dimensioned damper windings, the influence of higher harmonics cannot be corrected in an effective manner. To meet the requirements of high-pressure testing the Oerlikon Company's engineers designed a special alternator, which is said to have given excellent results wherever it has been installed. The rotor and stator are composed of laminated steel. The field winding is distributed over the whole periphery of the rotor, which is provided with a damper winding in the form of a squirrel cage. The higher harmonics are further reduced by suitably designing the windings and slots. By means of these various devices it has been found possible to obtain pressure curves which depart from a true sine curve to a very

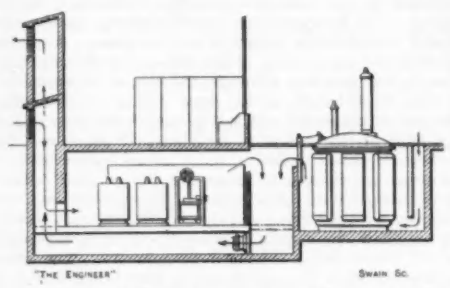

FIG. 3—GENERAL ARRANGEMENT OF TESTING PLANT

small degree; smaller, in fact, than the degree of precision of the standard oscillographs.

When the tests are of short duration, however, and in the cases of tests that do not call for strict attention to the form of the pressure wave, there is no objection to the supply being drawn from the distribution system.

When the H.T. testing plant is intended for the testing

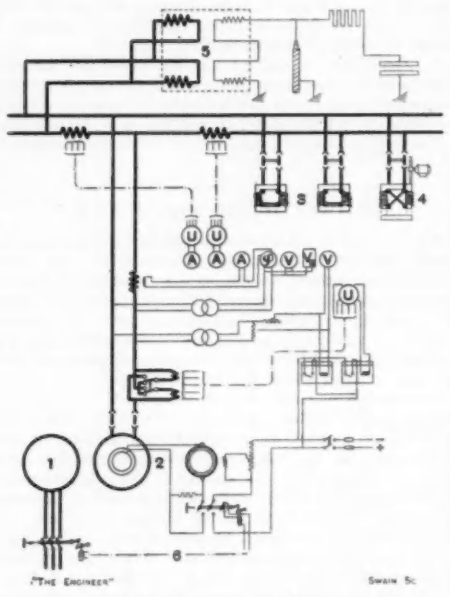

FIG. 4—DIAGRAM OF CONNECTIONS

of parts of high capacity, such as cables, the alternator or induction regulator need not be designed for the full capacity of the transformer, as the greater part of the capacity current is then compensated by means of adjustable or non-adjustable reactance coils connected on the primary side of the transformer. The output of the alternator is then fixed by the amount of power which has to be supplied to the transformer and to the reactance coils for covering their losses as well as for satisfying the conditions as regards stability.

Besides supplying H.T. testing equipment to various concerns, the company has installed a million-volt, 1200-kVA plant in its own works, comprising a set of three cascade-connected transformers mounted on insulated supports, as shown in Fig. 1, one pole of the transformers being connected to earth. The apparatus to be tested can thus be put under tension without having to employ an insulating platform. A large tank from which the air can be exhausted is provided for the testing of insulating material in oil, the pressure being measured with spheres 1000 mm. in diameter. The alternator, which is also suitable for use with other testing equipments, has a capacity of 560 kVA and is directly coupled to a 520 H.P. synchronous motor. The compensating current is supplied by two reactance coils, one of which is adjustable and remotely controlled by means of a servo motor. Whilst making tests the control operations are carried out from a switch desk, which is provided with a supervisory diagram with pilot lamps and miniature switches, and a panel arranged near the oil tank serves for duplicate control.

Of the testing equipments which the Oerlikon Company has made for other electrical firms, one of the most interesting is that supplied to the Société d'Exploitation des Cables Electriques Systéme Berthoud Borel et Cie., of Cortaillod, Switzerland. As in this case the equipment is intended for carrying out continuous pressure tests on drums of cable there is, of course, a heavy capacity load, and reactances are provided for compensating the capacity current. The pressure is derived from a single transformer with one pole earthed, and the secondary winding can be

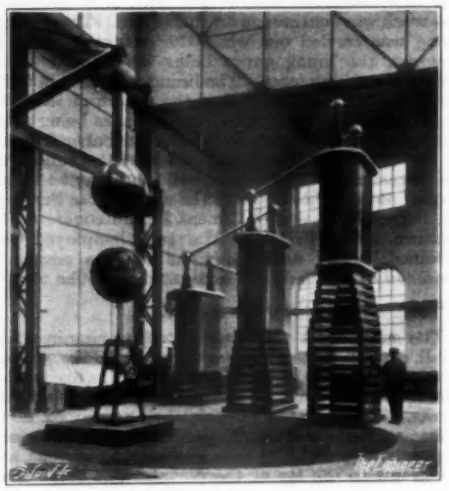

FIG. 6—750,000 VOLT TESTING EQUIPMENT

arranged so that it may be connected to give its full output of 1200 kVA at 200,000 or 100,000 volts. The transformer is shown in Fig. 2, and the general arrangement of the plant in Fig. 3; Fig. 5 shows the control room, and Fig. 4 is a diagram of connections of the plant. 1 is the synchronous motor; 2, the single-phase alternator with exciter; 3, non-adjustable reactances; 4, an adjustable reactance; 5, the testing transformer; and 6, a tripping device.

Before the plant left the Oerlikon works it was subjected to a pressure of 400,000 volts for five minutes, the pressure being derived from the transformer itself. Although the transformer is for testing purposes, it complies with the regulations of the V.D.E. for ordinary transformers for continuous operation at 200,000 volts. The alternator is a 560 kVA machine and is driven by a synchronous motor, which also serves for compensating the wattless load on the internal distribution system of the works. The reactances for compensating the capacity current of the cables are subdivided into three units, one adjustable and two non-adjustable. The whole equipment has been arranged with a view to ensuring ready access to the plant, easy control, and supervision. The transformer is placed in a pit with its cover flush with the floor; the control gear and all the instruments are grouped on a switch desk and a panel in the control room under which the alternator and reactance coils are arranged. Another Oerlikon testing equipment is shown in Fig. 6. It was supplied to the Université Libre de Bruxelles, and is designed for a pressure of 750,000 volts.

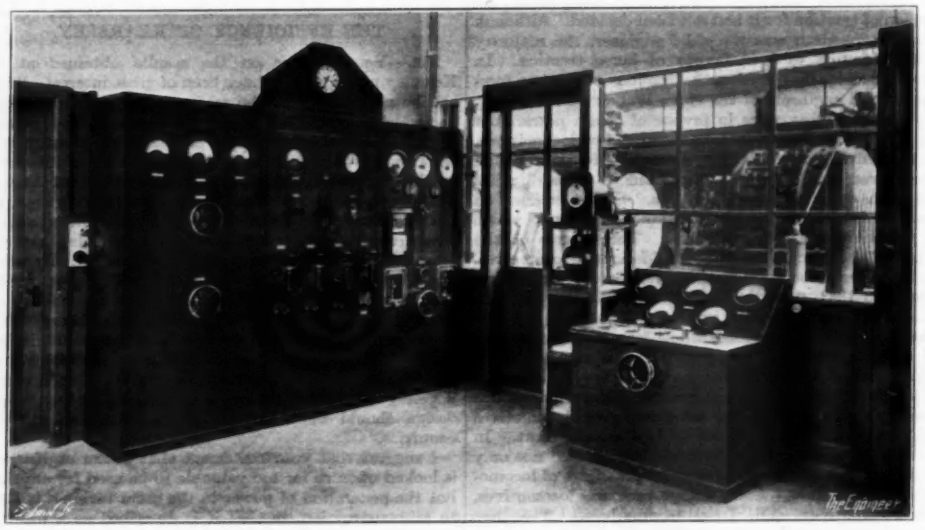

FIG. 5—CONTROL ROOM FOR 200,000 VOLT EQUIPMENT

Railway and Road Matters.

AN aluminium sleeping-car is to be constructed for experimental purposes by the Pullman Company, in co-operation with the Aluminium Company, of America. It is thought that an aluminium Pullman car could be built with a saving of 30 to 40 per cent. in weight compared with the present all-steel type of car. This would reduce hauling costs considerably, but whether sufficiently to counterbalance the increased cost of construction remains to be seen. The experimental car will probably be exhibited at the Chicago World Fair in 1933; steel will still be used, of course, for the wheels, brakes and springs.

THE report of Lieut.-Colonel Anderson on the collision on a goods line at Northumberland Park, London and North-Eastern Railway, on January 7th last, wherein three men were killed as a consequence of an outbreak of fire caused by the contents escaping from two wagons containing petrol, has been issued. It recommends that the operating rules be altered so that such wagons shall be placed as far as possible from both the engine and the brake van and that tank wagons containing inflammable liquids of a low flash point should be painted differently from those carrying liquids of a high flash point.

ONE of the yearly returns issued by the Ministry of Transport is known as the Railway Staff Census. It shows the number of railway servants, by their various grades, employed by British railways who are subject to the conciliation scheme. That for 1931, i.e., those servants on the pay rolls for the week ended March 7th last, has just been issued as a Stationery Office publication, price 1s., and shows that the number was 615,592, as compared with 656,530 in 1930, a reduction of 6·24 per cent. The total amount of salaries and wages paid during the year 1930 was £114,536,000, as against £115,284,000 in 1929.

IN view of the forthcoming retirement of Mr. C. Crump, the locomotive running superintendent and outdoor assistant to the chief mechanical engineer, Great Western Railway, Mr. F. E. Hall, the Bristol divisional locomotive superintendent, has been appointed to succeed that gentleman. Mr. Crump served his time in the Wolverhampton shops and, except for two years when he held an appointment in Spain, was there until 1905, when he went to Swindon and thence to London. He succeeded Mr. H. Simpson in his present position in 1922. Mr. Hall was for five years Mr. Crump's assistant and went to Bristol in 1929.

WHEN sleeping accommodation for third-class passengers was introduced on British railways in the autumn of 1928 ordinary corridor stock was used and the compartments could be used as usual during the day and made up to sleep four passengers at night. That is now being changed on the London and North-Eastern by the design, by Mr. Gresley, of a coach devoted only to night use as a sleeping car. It is 5ft. longer than the ordinary vehicle and provides berths for thirty-two passengers instead of twenty-eight. The exclusive use of the new stock for sleeping purposes has removed the necessity to have windows on the corridor side of the compartment, and the sliding door has a mirror. Ten new coaches of this type are being built.

STUDENTS of railway signalling always have been impressed by the fact that, although continental railways do not follow the British method of using a token for the operation of their single lines, collisions on such lines are almost as rare as they are in Great Britain. The continental lines rely, almost universally, on lock-and-block, whereby a second train cannot enter a section, nor can an opposing train, until the train already signalled has cleared the section. Despite that there was a serious collision near Leoben on the Prague division of the Austrian Railways in the early morning of August 16th. The Rome-Vienna express ran into part of a goods train which had broken loose from the rest of the train. Fourteen passengers were killed.

THE unusual accident which occurred on the night of August 15th to an up East Coast express from Aberdeen to King's Cross on Cockburnpath bank permits of a reference to runaway catch points. To intercept any vehicles that may break away, as the result of the failure of a coupling on a train that has been pulled up at a signal on a gradient steeper than 1 in 260, there is provided, a train's length in the rear of such a signal, a pair of switches which are trailing to normal running but facing, and ready to derail, any vehicles that run back. We do not know what happened on the occasion in question, but presume that the train "stalled" on the bank and that the driver set the train back, in order to get a better start, and forgot the presence of the catch points. A warning board of the presence of catch points is usually provided, but, like speed restriction and whistle boards, it cannot be seen at night.

THE 25th instant will be the seventieth anniversary of the disaster in the Clayton tunnel of the London, Brighton and South Coast Railway. Inasmuch as the twenty-three passengers killed represented not only the largest number of lives lost in a railway accident up to that time, but remained so until the thirty-one killed in the Abergele disaster of August 21st, 1868, some mention of it in this column is justified. Three trains left Brighton on the Sunday morning in question, which, despite the rule as to ten minutes' interval between each train, had only three minutes between the first and second and four minutes between the second and third. A signalman was stationed at each end of the tunnel, and as the man at the southern end had not had the "line clear" signal from the northern end for the first train, he showed a red flag against the second train. The driver of the latter train had expected to find a clear road, as the distant—a self-acting signal—was "off" owing to a failure in its mechanism, but he obeyed the red flag. He could not, however, pull up in time and his train had entered the tunnel when he stopped. When, soon after, the "line clear" signal was received from the northern end, the signalman thought it referred to the second train and so he showed a white flag to the driver of the third train, which consequently ran into the standing train. It was typical of the ideas that prevailed at that time that the L.B. and S.C. officials told the Board of Trade that they "still fear that the telegraphic system of working recommended by the Board of Trade will, by transferring much responsibility from the engine-drivers, augment, rather than diminish, the risk of accident."

Notes and Memoranda.

IN New Brunswick oil is being sprayed on to the roads for the purpose of allaying dust, at a pressure of 40 lb. per square inch. Up to the present no appreciable pressure has been used.

THE Kaieteur Falls of the Potaro River in British Guiana are 741ft. high, and the river, just above, is 400ft. wide by 35ft. deep. Below there is another drop, making the total fall 840ft., or about five times that of Niagara.

THE South Metropolitan Gas Company claims to have devised a bathroom geyser which will heat 2½ gallons of water from 55 deg. Fah. to 126 deg. Fah. in a minute, and is operated automatically by the turning on of the hot water tap.

THE period of service of locomotives on the South African Railways between the times when boiler failures occur through the use of impure water has been increased from 35,000 miles to 100,000 miles by the efforts of the department of analytical chemists organised by the department.

THE construction of the great new Cunarder being built on the Clyde is calling for the services of engineering firms throughout the country. The rudder, for instance, which will weigh more than 150 tons and will be the largest ever made, is to be made at Darlington, while the propellers are to be cast in London.

AT the salt pans of the Bloemhof district of the Vaal, South Africa, the brine is generally evaporated by exposure to the sunshine, and, in the winter, crystals of sodium sulphate—Glauber's salt—as big as a foot long are often obtained. With the summer evaporation, however, the crystals are smaller and are mixed with those of common and Epsom salts.

IN a note on Dr. G. W. C. Kaye's recent lecture on noise before the Royal Institution, *Nature* says that from noise measurements made inside buildings it is evident that stillness could be much more readily obtained in the Victorian home with its general solidarity, heavy hangings, and absence of loud speaker and gramophone, than in the modern ideal home with its thin walls and flimsy hangings.

IN considering the proposition of a canal across Nicaragua, in parallel with the Panama Canal, the *Engineering News-Record* says that the present capacity of the canal is thirty-two lockages a day. "The highest average reached to date was 16·7 in 1928, little more than half the present capacity. With a third set of locks and the additional water supply from Madden reservoir, the daily average can be increased to sixty, sufficient for many years to come. If the Government can find the 750,000,000 dollars required to build a canal across Nicaragua, it should be spent nearer home in a more productive enterprise."

FIRES start more readily in a red pine forest than in a mixed forest of white and red pine. Careful measurements, made by the Canadian Forest Service, showed that, in a red pine forest, litter containing 35 per cent. moisture would burn as readily as litter in a mixed white and red pine forest that contained only 23 per cent. of moisture. This arises, of course, from the fact that red pine needles are larger, contain much resin, and lie loosely on the ground, allowing much space for air to circulate, while in the other forest, the needles pack more closely together and so retain their moisture better and, at the same time, allow less circulation of air.

HERE are some remarks, taken from *Industrial Gases*, on the explosion of an acetylene generator, which resulted in the death of a lad. The occurrence is outlined and some comments by the daily Press quoted; it then goes on to say: "Comment upon these extracts is, we feel, superfluous. The generator which exploded had very little more relationship to what is required in a welding generator by the British Acetylene Association regulations than a milk can. Every accident, fatal or otherwise, due to an inadequately fitted or carelessly used generator, or one that is not kept in proper order, is liable to bring discredit upon the industry as a whole, and a case of this kind points to the necessity for more stringent official supervision."

IN the welding of Hadfield manganese steel by means of the blow-pipe, a manganese steel rod of the same composition as the bare metal must, says *Oxy-Acetylene Tips*, be used. The use of a flame having a slight excess of acetylene will assist somewhat in making a sound weld. A large flame should be used and a large pool of melted metal maintained. The rod should not be rubbed in the weld, but it should be left in the pool and melted under the surface of the liquid metal. When the pool is built up sufficiently, it should be melted into the base metal by applying heat around the edges until the weld and base metal flow together of their own accord. The material should be preheated and reheated in a manner similar to the usual practice for cast iron. Because of the brittleness of red-hot manganese steel, care should be taken to support heavy pieces against strain during welding.

A BOOKLET on "The Desulphurisation of Cast Iron by Means of Soda Ash" has been issued by Imperial Chemical Industries, in which it is pointed out that it has been established conclusively that a 50 to 60 per cent. reduction in the sulphur content of cast iron can be effected by the use of relatively small proportions of soda ash. The use of soda ash as a desulphurising agent successfully overcomes the difficulty of sulphur in cast iron. Low-sulphur content in pig iron does not infer a low-sulphur content in the finished castings unless high-quality coke is used, and only a limited proportion of scrap is remelted in the course of production. The necessity of reducing the sulphur content to meet the requirements of the modern specification has, therefore, imposed restrictions on the foundry industry in the choice of raw materials, and thereby increased the cost of manufacture. The problem is of special importance when the metal is required for conversion into steel by the Tropenas converter. The process of desulphurising by means of soda ash is both simple and inexpensive. It can be applied at various stages in manufacture. The cost is about 1s. 6d. per ton of metal.

Miscellanea.

IT is proposed to manufacture steel at the Mysore Ironworks, India. The necessary extensions will cost about £82,500.

THE Norwegian Whaling Association states that no Norwegian whaling expeditions will be sent to the Antarctic this year.

THE new 12,500-kW Parsons turbo-alternator at Port Elizabeth, South Africa, has been put in commission and two old smaller sets are being dismantled.

IN October next the Birmingham automatic telephone scheme will be extended to embrace the Sheldon Exchange, which will be the fifth exchange in the Birmingham area to be transferred to automatic working.

THE Town Council of Graaf-Reinet, South Africa, proposes to expend £30,000 on the conversion of the local electricity supply from direct to alternating current, and to equip the local power station with two new units of 250 kW each.

A NEW coal shipping plant is to be installed at the Royal Docks, Grimsby, by the London and North-Eastern Railway. It is to have a capacity of 1600 tons a day, and will be equipped with four sets of double hydraulic wagon tipplers capable of handling 20-ton wagons.

A FLOATING power station has been put into service at Bangermasin, Dutch East Indies. It was necessary to extend the local power plant, but there was not a suitable site. A 600 H.P. oil engine set was therefore installed on a pontoon 82ft. by 26ft., drawing 5ft. of water, which was moored alongside the existing power-house.

ACCORDING to the Bulawayo papers, a recent strike of a particularly rich copper ore body at N'Changa has considerably brightened the outlook. It is understood that the assay actually showed 72 per cent. copper This ore is as rich as that of the Kipushi Mine in the Katanga, which is generally accepted to be the richest in the world.

FOR three years the establishment of a national steel industry in Jugoslavia has been discussed, and negotiations with the Skoda and Krupp works had proceeded to the extent that a preliminary contract had already been signed. Now the agents of the works have been informed that owing to the difficult situation in the market the plan has been postponed for at least another two years, as it is cheaper to import the products than to produce them in the country.

A SCHEME is, says the *South African Engineer*, being prepared to pipe in another 5,000,000 gallons of water per day to the Rand. The Rand Water Board can at present supply 20,000,000 gallons of water a day, of which 10,000,000 gallons comes from the Vaal River barrage. It was only in October, 1928, that an extra 5,000,000 gallons was piped into the Rand. Water may, says that journal, yet be one of the big problems with which the growing Rand will have to contend with.

THE Japanese Government proposes to expend 22 million yen on the improvement of fifty ports and harbours. Among the places concerned there are:—Misumi, Oita, Sakata, Hososhima, Hiroshima, Shikama, Kishiwada, Uo, Tokushima, Nishinomiya, Miyazu and Shin-Maizuru, Akashi, Mogi, Ebisu and Teradomari, Nakaminato, Matsusaka, Taketoyo and Handa, Shimoda, Ishimaki, Kamaishi, Kamo, Itozaki, Wakayama, Uwajima and Mitsugahama, Unoshima, and Karatsu.

APPROXIMATELY one hundred scientists and business men from the principal countries of the world have tentatively accepted invitations to speak before or to send papers to the Third International Conference on Bituminous Coal to be held under the auspices of the Carnegie Institute of Technology, Pittsburgh, Pa., U.S.A., November 16th–21st, 1931, and the number of delegates and speakers is growing daily. Half the papers will be contributed by representatives of countries other than the United States.

SIX young South Africans have been selected by the directors of the South African Iron and Steel Industrial Corporation to be sent overseas to study the most modern methods of iron and steel production in England and Germany, and possibly in Sweden. These students will enter into the employment of the South African Iron and Steel Corporation. They will be paid a starting salary of from £20 to £22 10s. a month while they are abroad, and on their return will be employed at the steel works, Pretoria.

SAMPLES of certain coal seams in Alberta and British Columbia are being collected by the Canadian Department of Mines, principally for coal classification purposes. Commercial developments concerning the mining and retorting of oil shale are being studied with particular attention to the Maritime Provinces. It is possible that developments in the natural gas industry throughout Canada in respect to drilling, recovery of naphtha and crude oil will be investigated and that further attention will be given to the utilisation of waste gas from the Turner Valley field.

THE official returns rendered to the Electricity Commissioners show that 785 million units of electricity were generated by authorised undertakers in Great Britain during the month of July, 1931, as compared with the finally revised figure of 786 million units in the corresponding month of 1930, or a decrease of 0·1 per cent. During the first seven months of 1931 up to the end of July the total amount of electricity generated by authorised undertakers was 6415 million units, as compared with the finally revised figure of 6207 million units for the corresponding period of 1930, representing an increase of 3·4 per cent.

CONTINUING its policy of concentration of production, the board of Vickers-Armstrongs, Ltd., has decided to transfer from its Erith works the manufacture of the products at present being carried on there. The manufacture of the heavier products of those works has already been transferred to the company's works at Newcastle and Barrow-in-Furness. The company now intends to concentrate the lighter products in its Crayford and Dartford works. In view of the proximity of the three works, the company does not consider that there will, in consequence of this rearrangement, be any serious disturbance of employment in the district.

THE GRAMPIAN HYDRO-ELECTRIC POWER SCHEME

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(*For description see page* 191.)

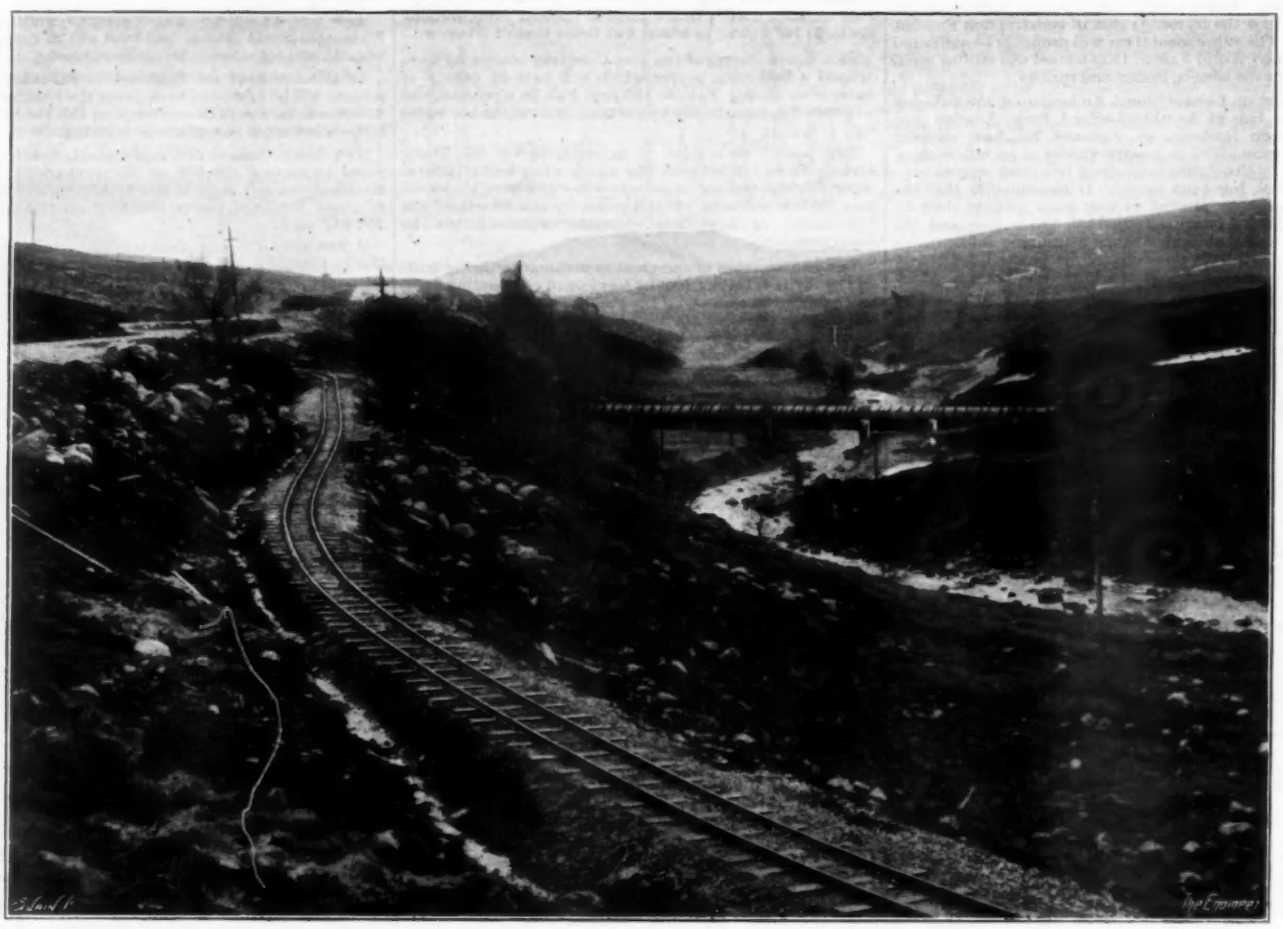

FIG. 24—RIVER CROSSING AND CONSTRUCTION RAILWAY

FIG. 25—STEEL PIPE AQUEDUCT OVER RIVER ERICHT

The Engineer

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† $15·25	New York, N.Y., December 12th, 1896, under the Act of March 3rd, 1879 (Section 397, P.L. & R.)

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Contents.

THE ENGINEER, August 21st, 1931.

	PAGE
A SEVEN-DAY JOURNAL	185
PRESS-TOOL AND FIXTURE DESIGN. No. II. (Illus.)	186
TECHNICAL PSYCHOLOGY. (Illus.)	187
THE GRAMPIAN HYDRO-ELECTRIC POWER SCHEME. No. III. (Illus.)	191
LETTERS TO THE EDITOR—	
Railway Electrification	193
Railways and the Public	193
The Efficiency of Kearsley	193
Stresses in Helical Springs	193
HIGH-TENSION TESTING EQUIPMENT. (Illus.)	194
RAILWAY AND ROAD MATTERS	195
NOTES AND MEMORANDA	195
MISCELLANEA	195
LEADING ARTICLES—	
As Others See Us	197
Technical Psychology	197
REPORT ON LONDON WATERS. No. II.	198
LITERATURE	199
BOOKS RECEIVED	199
GEOPHYSICS. No. IV. (Illus.)	200
PANAMA CANAL DEVELOPMENTS	202
AMERICAN ENGINEERING NEWS	202
SIXTY YEARS AGO	202
INTERNATIONAL UNION OF PHYSICS	202
IRON AND STEEL PRODUCTION IN JULY	202
AN AUTOMATIC REGULATOR. (Illus.)	203
CANADIAN ENGINEERING NEWS	205
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	205
Lancashire	205
Sheffield	206
North of England	206
Scotland	207
Wales and Adjoining Counties	207
CONTRACTS	207
CATALOGUES	207
LAUNCHES AND TRIAL TRIPS	207
CURRENT PRICES FOR METALS AND FUELS	208
FRENCH ENGINEERING NOTES	209
BRITISH PATENT SPECIFICATIONS. (Illus.)	209
FORTHCOMING ENGAGEMENTS	210
PERSONAL AND BUSINESS ANNOUNCEMENTS	210

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THE ENGINEER.

VOL. CLII. No. 3945

AUGUST 21, 1931.

As Others See Us.

THERE is no nation in the world so prone to self-depreciation as the English of to-day. In this case we need make no apology for saying "English" instead of "British," for we fancy that the defect, and a defect it is, begins south of the Tweed. If self-criticism could be kept within the four walls of England its advantages might outweigh its ill-effects. Unfortunately, it spreads to other nations, which not only accept us at our own valuation, but stretch a point or two for the benefit of their own industries and the discouragement of ours. Can it be possible that the correct interpretation of Burns' famous wish is that if we could see only ourselves as others see us, we should have a better conceit of ourselves and be thereby stimulated and enheartened! At any rate, we may take it that however much an Englishman may criticise himself he hopes other people will take a more generous view and protest that he has a few merits left. Unfortunately, that hope is rarely satisfied.

Whilst there is no English industry which escapes odious comparisons between its methods and those of its foreign competitors, engineering of all kinds is more frequently attacked than any other. The critics, it may be observed, are, frequently, people who know very little about engineering, and are sometimes wholly unfamiliar with the conditions which prevail in this country. They visit America or Germany, are shown the "star turns" amongst the factories of those countries, and straightway condemn the methods of their own land. Now, it may be said, in general terms, that the industries of every country are carried on by methods which suit the conditions of that country and that they cannot be translated from one land to another without modification. Every American firm that has set up a factory in Great Britain has discovered that fact—sometimes to its cost. There is no escape from the effect of environment, and it is as vain to expect an American or German system to flourish without modification in this country as to expect tropical plants to grow in equal luxuriance in temperate climes. If that fact were borne in mind by critics their observations might prove more directly useful to home manufacturers and less profitable to foreign competitors. Fortunately, there are critics of another kind, but, unhappily, they speak as experts and their voice is rarely heard by those outside a limited circle. One such spoke at the June Convention of the Institute of British Foundrymen, when an address was given by an engineer who has the necessary qualification for a sound judgment. Mr. L. H. Pomeroy, of the Daimler Company, spent several years in the American motor car industry, and is as familiar with its details as with those of the corresponding industry in this country. "In these days," he said, "when the Press is full of national disparagement, the author feels it is the duty of those who have experience of other countries to contribute such knowledge as they may have to enable us to see ourselves as we are." He then pointed out that in the United States "the motor car is the only article of public consumption which is cheap, relatively and absolutely." But to produce the cheap car mass production is essential, and a very interesting effect has followed. All managers know that after a certain scale of production has been attained the influence of the hourly rate of wages is of little importance by comparison with the expenditure on machinery equipment and organisation. Sir Eric Geddes gave several examples in a recent article. In one case, which is quite typical, the manufacturing conversion costs in motor car production before the war were composed of 62 per cent. of production labour costs and 38 per cent. of all other costs, except materials, general administration and selling. The same items are now, in the same firm, 20 per cent. labour and 80 per cent. for all other costs. In these circumstances, high hourly rates were introduced by Mr. Ford and have been followed in other American motor car factories. The result is that wages in other engineering industries have been pushed up also, despite the fact that, not being mass-producing, the ratio of wages to total cost is much greater. Hence a serious handicap is imposed on those industries. That is the kind of fact with which the ordinary lay critic of British methods is not familiar; but it is essential that due weight should be given to it. A great deal of engineering manufacturing in this country can never be carried out by mass production, and, therefore, could not bear the wage rates that are possible in the United States. If an attempt were made to pay wages on that scale there would immediately be such an increase in cost that our essential foreign trade would be lost. We have Mr. Pomeroy's testimony that in our own field we are better than the Americans. "In actual fact," he said, "the time taken in making a pattern or a die or any individual piece is very considerably greater in the U.S.A., which is reflected in the cost for a pattern or a die or any special piece of work being about four times what it is here." He is convinced, too, that "the basic education, training, skill and natural intelligence of the British worker, either in the shops or in the office, are very definitely higher than in the U.S.A."

Mr. Pomeroy takes a high view of the position which the motor car industry of Great Britain is destined to attain in British Imperial trade. We trust that he may prove to be a sound prophet. Much depends upon our own and Dominion politicians, but if they can or will come to reasonable terms there is no reason at all why the motor car industry of the British Empire, centred by common consent in Great Britain, should not be as great as that of the United States. But if that should occur, we must see to it that it does not have the same result as it has had in America. There, as Mr. Pomeroy has shown, it has caused such a general increase in wages that the cost of all other products has been elevated to a point which has almost destroyed the export trade. In America that does not matter very much, but to us failure in ability to compete with foreign rivals would be disastrous, and in the event of such a danger arising, industrial economists would be compelled to ask themselves whether it were not better to preserve those engineering industries which thrive on a limited output—for which the mechanical genius of our people gives us a particular aptitude—than to seek for the then dangerous benefits of mass production. We do not offer any opinion on that problem, but we do ask lay critics to remember that it exists and to be the more cautious in advocating the wholesale Americanisation of British industries.

Technical Psychology.

IN an article published elsewhere in this issue a contributor, Mr. R. A. Bell, gives an interesting summary of a variety of fitness and suitability tests which he found in use during a personal inspection of a large number of European factories. The

technico-psychological tests which Mr. Bell describes are designed by their authors to determine the suitability for particular duties of candidates for employment, to provide a means of gauging the acquisition of technical efficiency under training, or as a means of recording the maintenance of efficiency, the retention of nerve and so forth at periodical intervals. In this country such tests are not regarded with great favour among employers, while it is not too much to say that by the general body of workpeople they are resented. During the war it was found desirable to introduce a system of ability tests for fitters and other skilled workers. The tests described by Mr. Bell, however, go far beyond the determination of a man's skill at his trade. They cover a psychological examination of the candidate's natural faculties and the extent to which he has sharpened them or suffered them to become dull. A good workman does not dread, but welcomes, an opportunity of demonstrating his handicraft skill. Railwaymen and sailors approve of and do not grumble at the vision and colour blindness tests which they have to undergo. But concerning the merits and the justice of some of the tests which our contributor describes, opinion, we are certain, will be divided, with perhaps a preponderance on the side of hostility.

There are certain special cases in which it is justifiable and desirable to subject a candidate for employment to a searching test of his natural characteristics and faculties. Such an instance is to be found, for example, in the testing of would-be pilots for aircraft. Several ingenious and elaborate machines for this purpose have been designed and used. An early form of the Reid time-reaction apparatus was shown by the Air Ministry at Wembley in 1925, and in the Engineering Department at Cambridge University we recently had an opportunity of examining an improved type of the device. It is in the nature of a movable cockpit fitted with the usual controls. By means of an autographic recorder the candidate produces a curve which shows the rapidity with which he operates the controls to correct a simulated dive, spin, &c., his ability to co-ordinate movement of his hands with movement of his feet, and his reaction to sudden unexpected nervous disturbances such as the blast of a Klaxon horn. The device has now been so highly developed that by its aid it is possible to discriminate candidates with a born aptitude for flying from those who with a reasonable amount of training would become satisfactory pilots and from those who with any amount of training would never be satisfactory. It is relied upon, we believe, even to the extent of providing an indication of the type of machine which a candidate would be best suited by his natural abilities to fly. Here we have an undoubtedly strong case for a testing machine that will translate a man into a curve. A similar system of testing might be useful and justifiable in connection with certain other callings, of which that of the omnibus driver is one of the most obvious. But as a general means of recruiting skilled, semi-skilled and unskilled workers for factory employment the principle of psychological testing will, to many people, workers and employers alike, appear undesirable. The value of some of the tests described by Mr. Bell is certainly not easy to see. The ability of a candidate to divide a line by eye into so many equal parts, to lay down an angle of ninety, sixty, forty-five or thirty degrees, to locate the centre of a circle, to arrange, by feel only, a number of sheet metal pieces according to their thickness, or to assort by his unaided judgment a number of diversely shaped parts according to their weight, does not seem to forecast his value as a workman in any way. Indeed, it might quite easily happen that his ready ability in these respects would actually be a reason against his being satisfactory. It might lead him to do "by eye" or "by feel" that which he certainly ought to do with the assistance of instruments. In this respect several of the tests described by Mr. Bell appear to be defective in principle. They call for the possession of powers which, however useful they may be on odd occasions, do not need to be possessed, and which in a great many cases are not possessed by perfectly satisfactory workmen. In an unskilled labourer the ability to divide a line into a number of equal parts is unnecessary and implies nothing concerning his labouring powers. In a skilled worker it might in some trades occasionally be useful, but in others or at other times it might readily prove to be a dangerous accomplishment. In another obvious respect several of the tests described by our contributor may be held to be faulty and likely to give seriously misleading results. They are nearly all liable to be upset by the reaction of the candidate to the fact that he is undergoing examination, and some of them, noticeably those making demands on the candidate's sensory acuteness, are open to passing influences which it would be unfair to ignore. A good workman is not equally satisfactory at all times of the day and the week. He has a temperament and a digestion and, unlike a machine, is not to be judged by his performance over some brief, isolated period.

It is stated by Mr. Bell that those in charge of the factories in which technical psychological tests had been adopted were found to be uniformly enthusiastic concerning the value of the results achieved. But are they really in a position to form a sound judgment? They know how many workers passed by the tests as satisfactory have justified the verdict. They do not and cannot, however, know how many men who would have been satisfactory have been rejected by the tests and denied employment. We may, perhaps, compare the tests to the examination of individuals for insurance purposes by a medical officer. The doctor may point to his company's results as evidence of the soundness of his system of examination. But unless he can show that he has not lost business for his company by rejecting candidates who would really have been satisfactory, the soundness of his system cannot be regarded as completely established. There will be many, we feel sure, who will agree with us that the general application of technical psychological tests to candidates for employment is undesirable in this country, and that the kindliest and withal the most efficient method of obtaining satisfaction in the recruitment of labour is by the familiar, somewhat haphazard, process involving personal judgment and a trial at the bench or the machine under ordinary routine conditions and extending over a reasonable period.

Report on London Waters.

No. II.*

Kempton Park Filtering and Pumping Station.

In our issue of August 14th we dealt with the first part of Sir Alexander C. Houston's Report to the Metropolitan Water Board, on the results, during the year 1930, of his chemical and bacteriological examination of London waters. In what follows we propose to discuss the second part of the Report, which comprises a description of the Board's Kempton Park station, that contains one of the largest and most up-to-date double-filtration installations that exist in the world. We ourselves gave a full description of this newly enlarged station in our issues of October 25th and November 1st, 1929, and on the present occasion we propose to confine ourselves rather to Sir Alexander's remarks on the station and to the results which are being achieved there, than to an actual description of the station itself.

For some years past now Sir Alexander has delighted the readers of these Reports of his by a series of charming sketches of various departments of the Board's undertaking. All of these essays have been gems of poetic prose, and one might be tempted by them to think that their author, were he not such an eminent scientist in so many directions as he is, had really mistaken his vocation and should have been an artist-poet. As a consequence of their non-technical nature, we have, with great reluctance, found ourselves compelled to refrain from reviewing all of them at length, as being not quite within our sphere; but several of them, and the present publication is one, contain enough of technical matter to justify a summary of it appearing in a scientific journal.

The Route to Kempton Park.

As a setting in which to frame his narrative Sir Alexander, who is telling the tale to would-be visitors, has chosen the most interesting route by which to reach the desired termination. He takes them nearly all the way-by water. "Life itself," he says, "is a long journey, beginning under the happiest of auspices and ending, shall we say, to avoid all questions of creed, most mysteriously in Home-land." There are some persons, happily few in number, who think only of the place to be visited and not of the journey to and fro. "It will not be so, it is," he adds, "to be hoped, in our case, for so much depends on the way and the spirit in which we approach our destination and return again." So he chooses the water route to Hampton Court as being the most pleasant, as well as being most befitting, since the travellers can the more easily learn something "about a river that yields 160 million gallons a day to thirsty London." The start is made from Westminster Pier and the disembarkation point is Hampton Court, the short remaining portion of the trip being covered by road vehicle. With that brief statement we must pass over the outward journey, leaving to those of our readers, who have the inclination, to obtain copies of this second part of the full Report, of which, we understand, it is proposed to print a large number, and themselves read the narrative with, we trust, as much enjoyment in doing so as we had.

* No. I. appeared August 14th.

Statistical Particulars.

To make this portion of the Report as complete in itself as possible, with a view to its being read by many who have no technical knowledge of London's water supply, a certain number of statistical figures are inserted at this point. The area of supply, we are told, exceeds 560 square miles and stretches from near Hertford in the north to Westerham in the south, and from Northfleet in the east to near Hounslow in the west. The River Thames furnishes 58 per cent. of the water supplied, the Lee 24 per cent., the remainder being provided by wells, springs, and gravel waters. Seven and a-half million persons—or more than the combined populations of Australia and New Zealand—are supplied. Some 274 million gallons—equivalent, says Sir Alexander, who delights in comparative figures, to one gallon to every seventh inhabitant of the world, or more than enough to support life to every second human being—are sent into the Board's distribution mains every twenty-four hours. There are 49 storage reservoirs, covering 2705 acres, equal in area to Richmond Park, Kew Gardens and Hampton Court Gardens together, and holding 19,657 million gallons, or enough to supply the whole world with a gallon of water for ten days or sufficient to support life for forty days. There are, too, 93 service reservoirs, holding 322 million gallons, or enough water to give, at 35 gallons per head per day, ten days' supply to Birmingham or a year's supply to the famous cathedral city of St. Albans. There are 178 slow sand filters, with a total acreage of 176, which equals Wandsworth Common in extent. The 272 engines aggregate 47,243 horse-power, and for every 1000 gallons of water pumped the fuel used—coal, coke, oil, and electricity—the cost was 0·56 pence. In all, there are 7111 miles of mains—a length as great as those of the Amazon and the Missouri taken together. "Few consumers," interjects Sir Alexander, "realise that more of the Board's capital has been sunk underground than is visible above ground." As an example, the mains laid in connection with the new Kempton Park works cost about £1,000,000, whereas the total cost of the new conduit, filtration house, pumping station, primary filtration plant, boilers, engines and service reservoir was about £660,250.

The Queen Mary Reservoir and Conduit.

The progress of the water from the River to the new works is then discussed. The intake from the Thames is just below Penton Hook Weir, and there the water is passed through and measured by three Venturi meters. From the intake building the water gravitates down an open channel about ¾ mile in length to a new pumping station, from which it is pumped into the Queen Mary—Littleton—reservoir, which holds 6750 million gallons, or enough water at 35 gallons per head per day to supply, say, Sheffield for over a year.* We are reminded that the water surface area in this reservoir is 723 acres, or about equal in size to Greenwich Park, Regent's Park, and Primrose Hill, taken together. The conduit from the Queen Mary Reservoir to the works at Kempton Park is about 2 miles long and 6ft. in diameter, and is made of reinforced concrete.† Cast iron pipes, 48in. in diameter, extend from that point to Hampton.

The Primary Filter House.‡

The primary filter house contains twenty-four primary filters—gravel and sand—each filter designed to deal with 1½ to 2 million gallons per day. The maximum capacity is thus 48 million gallons a day, "a wonderful output," says the Report, "considering that the total area is only 9984 square feet." These primary beds are, normally, fed with water through a conduit laid in connection with the 6ft. conduit from the Queen Mary Reservoir. The levels are such that down to a certain top water level in the reservoir the water can gravitate from it direct to the primary filters, and thence to the secondary slow sand filters. Should the water in the reservoir be drawn down below that level, however, there is provision by which the water can be pumped from the conduit to the primary filters. The primary filters are cleaned by means of air jets and back-flush operations in the ordinary manner, the wash water, which is obtained from a tank in the roof of the filter house, gravitating, after cleansing the filters, into sedimentation tanks below and forming the foundations of the filter beds. The sediment is flushed to lagoons outside the building, where it dries in the air.

The water discharged by the Primary Filters gravitates through a conduit under a roadway to a series of twelve pre-existing slow sand filters, having a total area of 9 acres, which, owing to the preliminary "heavy" work done by the primary filters, can be worked much faster than is customary with slow sand

* This part of the Board's undertaking was described in our issues of June 19th and 26th, 1925.

† It was described in our issue of January 29th and February 5th, 1926.

‡ See The Engineer, October 25th and November 1st, 1929.

filters. The finally filtered water, before being pumped into supply, is treated, first with ammonium sulphate and then by gaseous chlorine, both being added as solutions. The average dose is 0·2—in terms of nitrogen—and 0·25 part per million gallons respectively. The ammonia is added *before* the chlorine, so as to avoid taste troubles. Ammonia is a taste *preventer* and not a taste *remover*.

Bacteriological Results of Treatment.

The bacteriological results obtained during the year 1930 with this stored and four-fold treated water are given in Table I.:—

Table I.

Description of sample.	Number of samples.	Average number of microbes per c.c. Agar at 37° C. (colonies counted after 20–24 hrs.).		*B. coli* test (typical *B. coli*), percentage results. Negative, 100 c.c. per cent.	Plus, 100 c.c. or less per cent.
Raw Thames water	249	358	—	0·0	99·9
Stored water from Littleton Reservoir	49	40	—	4·1	95·9
Mixed filtrates from Primary Filters	249	17 (*a*)	—	22·9	77·0
Average results of Secondary Filters	266	7·6 (*a*)	5·0 (*b*)	85·7	14·3
Final filtrate from general filter well (chlorinated)	248	2·2 (*a*)	2·2 (*b*)	98·0*	2·0

(*a*) Inclusive of all results. (*b*) Exclusive of samples containing 100 or more microbes per c.c.
* Since February 24th all the samples—211 in number—have contained *no* typical *B. coli* in 100 c.c. of water.

It is to be noted that storage reduced the microbes from 358 to 40—a reduction of over 88 per cent. The *B. coli* results are, however, described as being "rather disappointing," as compared with other storage results obtained by the Board. The primary filters reduced the number of microbes from 40 to 17, or nearly 58 per cent. reduction. The secondary filters reduced the microbes from 17 to 7·6—55 per cent.—taking the inclusive (*a*) figures, or to 5·0–71 per cent., taking the exclusive (*b*) figures. The *B. coli* results were exceptionally satisfactory, the number of first-class samples—negative 100 c.c.—being actually 85·7 per cent. The final filtrate from the general well gave, after chlorination, the following results, which are designated as "wonderful": Number of bacteria per c.c.—agar at 37 deg. Cent.—2·2, a reduction over 99 per cent. as compared with the *raw* river water; and whereas 89·1 per cent. of the samples of *raw* river water contained *B. coli* in 1 c.c. (or less), only 2 per cent. of the samples of finally treated water contained *B. coli* in 100 c.c.

Chemical Results, Parts per 100,000.

The average chemical results obtained during the year are summarised in Table II.:—

Table II.

Description of sample.	Number of samples.	Ammoniacal nitrogen.	Albuminoid nitrogen.	Oxidised nitrogen.	Chlorides expressed as chlorine.	Oxygen absorbed from permanganate, 3 hrs. at 80° F.	Colour m.m. brown, 2ft. tube.	Total hardness.	Permanent hardness.
A. Raw Thames water	247	0·0072	0·0136	0·24	1·83	0·192	64	23·2	5·5
B. Littleton Reservoir stored water	49	0·0066	0·0187	0·16	1·71	0·148	36	20·3	5·6
C. Mixed primary filters	98	0·0029	0·0111	—	1·72	0·124	36	—	—
D. Kempton Park final filtrate general well	179	0·0186	0·0070	0·16	1·74	0·097	25	20·6	5·9

It will be noted that the storage actually increased the albuminoid nitrogen figures which, the Report explains, was, no doubt, due to algal growths. The oxygen absorbed and colour results, however, were reduced by nearly 23 and nearly 43 per cent. respectively, while storage had also a slight softening influence.

The primary filters reduced the ammoniacal nitrogen, albuminoid nitrogen, and oxygen absorbed figures by about 56, 41, and 16 per cent. respectively, but the colour was unaffected. The secondary filters reduced the albuminoid nitrogen, oxygen absorbed, and colour figures by about 37, 22, and 30 per cent. respectively. The ammoniacal nitrogen figure was increased, but that, we are told, was due to the artificial addition of ammonium sulphate solution to the water to prevent taste troubles.

Efficiency of Primary Filters.

The Report is illustrated by a most interesting series of half-tone reproductions of strictly comparable photographs of various waters. The engravings are in sets of three, some of them showing the water before filtration, the wash water, and the filtrate, while others represent the water before filtration, after primary filtration, and after secondary filtration. Those showing the comparison between raw water and wash water are, for the most part, extraordinarily alike, which showed that the primary filter was doing excellent work and holding back nearly all the larger elements, so that more rapid passage of the water through the secondary filters was evidently practicable. The filtration was at the rate of 305 gallons per square foot per hour and no coagulant was used. The experiments were carried out some years ago with some specially prepared filters installed at Hampton. It was on these and on other experiments carried out at Barn Elms that the installation at Kempton Park was designed. The Board had thus a scientific background to the use of primary rapid filters, and did not embark on a new, and to some extent speculative treatment, without full knowledge of what primary rapid filters could do in the matter of removing most of the algal growths from Thames-stored waters. The primary filters at Kempton Park were worked at an average rate of 138·8 gallons per square foot per hour, and the secondary filters at an average rate of 3·62 gallons per square foot per hour.

Sterilisation.

It may be said, Sir Alexander comments, that the filtered water from the secondary filters was so good bacteriologically that chlorination was unnecessary, but the works, in their present state, have been, he goes on to say, in existence for too short a period to judge of the super-efficiency of the filters, and the cost of the sterilisation is so small that this final safeguard should not be lightly, if at all, abandoned. It is always to be remembered, he adds, that filtration is almost entirely a mechanical process, and that some of the bacteria are not held back by the filters. The maximum quantity of water filtered at Kempton since the installation of the primary filters is 36 million gallons a day or 2½ times the normal daily output of the station prior to the construction of these filters, a rate which might have been increased.

Quoting from a paper read before the Institution of Water Engineers by Mr. Walker, Deputy Chief Engineer of the Board, Sir Alexander then goes on to say that, assuming the maximum economical rate of filtration through the Kempton Park secondary filters of pre-filtered water to be 5 gallons per square foot per hour, or approximately 2½ times their average rate in the past with raw water, it would have been necessary to increase the area of slow sand beds from the existing 9 acres to approximately 22 acres to deal with the quantity of water that represents. The additional area of 13 acres would have entailed an expenditure of about £260,000, taking the cost of construction of slow sand beds at £20,000 per acre, exclusive of land. The cost of the complete primary installation was £115,000, including the cost of mains and chlorination plant. The adoption of primary filters, therefore, reduced the necessary capital expenditure by £145,000, or 55·7 per cent.

Conclusion.

There is much more in this Report that is of great interest to the consumer of London water, but space prevents our making reference to it. We would only add, in conclusion, that Sir Alexander leads his visitors back to the Board's water research laboratories at 20, Nottingham-place, by way of Twickenham, Isleworth, Brentford, Hammersmith, Hyde Park, and the Serpentine, which, he remarks in passing, is a lovely expanse of water in the heart of London, and which, 1930 being its bicentenary year, deserves more than a mere passing mention. It may be added that at the laboratories, to inspect which all water consumers are cordially invited, no fewer than 16,215 *routine* samples were examined, either bacteriologically and chemically or both during the year under review, in addition to some 4000 samples examined annually for special purposes.

Literature.

SHORT NOTICES.

A History of the British Chemical Industry. Written for the Society of Chemical Industry by Stephen Miall. London: Ernest Benn, Ltd. 1931. Price 10s. 6d.—This book has been written at the request of the Society of Chemical Industry on the occasion of its fiftieth anniversary. It is not a technical work, though of necessity a certain amount of technology enters into it, for one cannot follow the history of any industry without knowing something of the technical and scientific influences which have brought about its development. In a Foreword Sir Harry McGowan, Chairman of Imperial Chemical Industries, Ltd., makes the striking statement that "the chemical industry is the most polygamous of all industries," by which he means that it has entered into alliances with the physicist, the biologist, the engineer, the electrician, the metallurgist, and others. Hence its remarkable history makes an appeal to everyone. It is a remarkable fact, as Sir Harry also points out, that in the chemical industry the names of the great pioneers "are kept alive for us to-day and honoured by us in the persons of their descendants, who are still active and in many cases notable personalities in the industry." Whether this family tradition is more pronounced in chemistry than in other branches of technology would form the basis of an interesting inquiry, but it certainly lends an additional attraction to the personal notes and portraits which are to be found in the volume.

Electric Motor Management. By H. Avery. London: Percival Marshall and Co., Ltd. Price 3s. 6d.—As a practical guide to the installation, management and maintenance of electric motors for factory engineers and power users this little book, comprising nearly 150 pages, is worthy of a place on the bookshelf. It deals in a very simple way with practical difficulties that are liable to be met with by those who are put in charge of electric motors, and it provides the reader with a certain amount of general information about electrical matters. It begins with an outline of electrical laws; it describes the difference between alternating and direct current, the meaning of frequency and power factor; and it explains the difference between single-phase and polyphase current. After dealing with the different types and characteristics of electric motors, the author shows how electric motors work and describes the details of construction. Subsequent chapters are devoted to motor specifications and operating characteristics, performance curves, starting and regulating devices, and the choice of motors. The book contains many diagrams of connections, all of which are drawn on simple lines. Although much has been written on the management of electric motors, Mr. Avery has provided a book which deals with the subject in a very simple and practical way.

Examples in Power Distribution and Electric Traction. By A. T. Dover. London: Sir Isaac Pitman and Sons, Ltd. Price 3s. 6d.—Although mainly suitable for students and particularly those preparing for university and diploma final examinations, the final examination in electrical engineering of the City and Guilds of London Institute, and the graduateship examination of the Institution of Electrical Engineers, the notes and examples contained in this book may prove useful to power distribution and traction engineers. In order to assist students engaged in private study the more important theorems and formulæ relating to power distribution are given in a separate chapter, whilst those relating to electric traction are arranged in chapters appropriate to the classification of the examples in the subject. Although as far as possible the examples have been selected from the examination papers of the University of London, City and Guilds of London Institute, and the Institution of Electrical Engineers, a number of examples have been compiled to suit the needs of particular problems. Within the space provided by eighty pages the author has succeeded in covering much ground and in providing students and others with many problems to solve. The main fault to be found with the book is that the print is small.

BOOKS RECEIVED.

Barrow-in-Furness: Commercially Considered. Barrow-in-Furness: The Town Clerk, Town Hall.

Journal of the British Wood-preserving Association. Vol. I. London: The British Wood-preserving Association, 166, Piccadilly, W. 1. Price 7s. 6d. net.

Coal Tar and Some of its Products. Second edition. By A. R. Warner. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 3s. net.

Henson and Stringfellow: Their Work in Aeronautics. By M. J. B. Davy. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 5s. net.

Investigation into the Strength of Rail Joints. By H. Howe, B.A., and L. H. Swain, B.Sc. Calcutta: The Manager, Government of India Central Publication Branch. Price 1s. net.

American Railway Signalling Principles and Practices: Chapter XVI., Interlocking. New York: Signal Section, American Railway Association, 30, Vesey-street, N.Y., U.S.A. Price 35 cents net.

The Ignition of Firedamp by the Heat of Impact of Coal Cutter Picks Against Rocks. By M. J. Burgess and R. V. Wheeler. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 9d. net.

Physical and Chemical Survey of the Natural Coal Resources. No. 18, *The Yorkshire, Nottinghamshire and Derbyshire Coalfield, South Yorkshire Area, The Barnsley Seam.* London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. net.

Geophysics.

No. IV.*

Seismic Methods.

In the first article of this series we described some of the earlier instruments used for the detection of earthquakes and found that even at the beginning of the nineteenth century the latest apparatus was at best a crude affair. Progress after that date, however, was more rapid, and as the instruments improved it was found possible from the results achieved to hazard answers to some of the questions mankind was asking as to the general structural character of the earth. The suggestion was soon made that perhaps instruments constructed especially for the registration of minor shocks might reveal the local geological structure of an area affected in some detail. Instruments of the kind were made and are now in use in many parts of the world, and in localities particularly suitable for seismic surveying have done work of considerable value.

To produce the minor shock required a small quantity of explosive is fired either on the surface or buried a few feet below ground level. The revelation of the geological structure is obtained by measuring the velocity of the train of compression waves set up in the ground by the explosion. These waves, in general, travel faster in dense or rigid than in lighter or less rigid materials. In general, again, they travel faster at a depth below the ground surface than along the top.

To study the structure, therefore, a number of instruments are set up along a straight line, at one end of which the explosion takes place. The time of arrival of the waves at each successive instrument is then noted and the results plotted as a time-distance graph. For instance—see Fig. 27 (*a*)—in a homogeneous medium the waves will travel with the same velocity in every part, so that they will arrive at the instruments in regular succession and the graph will be a straight line. Usually in the field, for reasons that will be explained shortly, a traverse line is "shot" in both directions, so that the two lines on the graph show times of arrival when the shot point was at O and at X respectively. If, however, the ground steadily becomes denser in one direction, curves similar to those to be seen in Fig. 27 (*b*) will be obtained. Here the ground is growing denser towards X, with the result that the waves travel faster in the ground near X than in that near O, the increase in speed being progressive.

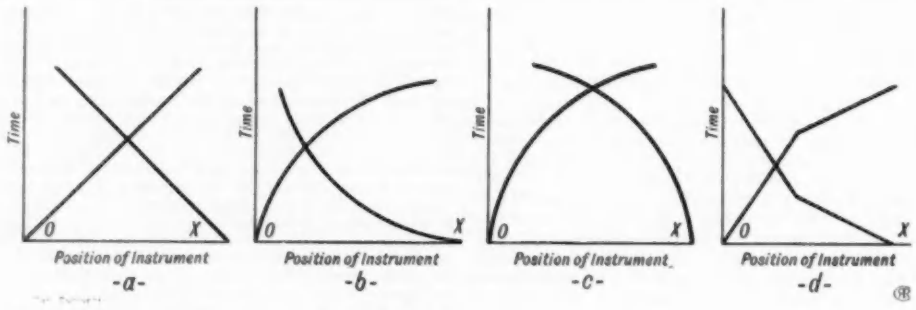


Fig. 27—Times of Arrival of Seismic Waves Passing through Various Ground Structures

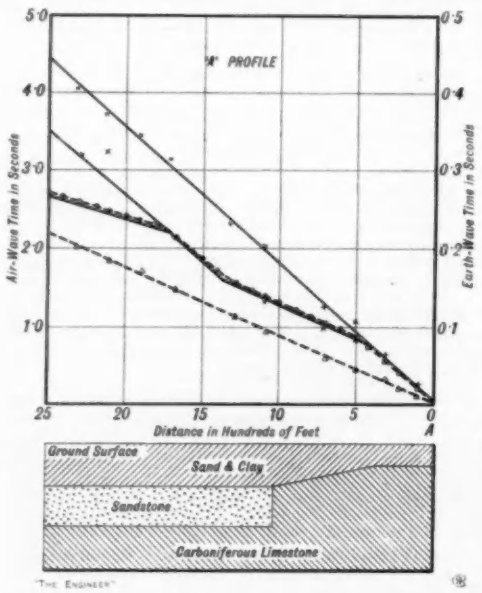


Fig. 28—Seismic Survey over a Known Ground Structure

So far we have dealt entirely with the surface wave. But waves are propagated from the shot point in every direction; and in a manner analogous to that of light these waves can be reflected and refracted if they encounter strata of differing density below the ground. For instance, if the material grows denser with increasing depth, the path of a train of waves may be a curve trending downwards from the shot point, becoming horizontal at a considerable depth and finally rising to the surface to affect an instrument. Owing to the fact that these waves have travelled for the most part in a denser medium than the surface waves, they will have had a higher velocity, and in spite of the greater distance they have travelled, may arrive at the instrument before the surface wave. In addition, the greater the distance of the instrument from the shot point the greater the depth to which the waves must have penetrated, and in consequence the greater the velocity with which they have travelled. It is clear that the time-distance graph recording the first arrivals will be a curve similar to that shown in Fig. 27 (*c*). If this graph Fig. 27 (*c*) is compared with that in (*b*) it will be seen that the two curves radiating from O are very similar. In fact, the conditions could be such that identical curves could be obtained for ground growing steadily denser in one direction or steadily denser with depth. But by "shooting" the traverse in the opposite direction it is possible to remove the ambiguity, as can be seen by comparing the two curves radiating from X. For that in (*c*), where the ground grows denser with increase of depth, it makes no difference to the arrival times in what direction the traverse is shot; but for that in (*b*), where the ground grows denser towards X, the velocity is always found to be greatest at the instruments most distant from the shot point; but for that in (*b*), where the ground grows denser towards X, the velocity is always found to be greatest at the X end. For a complete solution, therefore, it is always necessary to "shoot" in more than one direction, and owing to its convenience it is usual to shoot the same traverse in opposite directions. The curves in Fig. 27 (*d*) show what is to be expected across a fault, the strata on one side of which transmit the waves with a greater velocity than those on the other.

When one layer is overlain by another it has been found that waves can travel for a considerable distance along the joint between the two strata, with the velocity proper to that of the lower, before reaching the instrument. In that case the "depth" wave may arrive before the surface wave and give rise to another type of characteristic curve, while reflection from the lower stratum can also occur. In the latter case, however, the reflected train of waves will probably arrive soon after the surface waves, and as the instrument is already in vibration it is frequently difficult to determine the time of their arrival. Nevertheless, the reflection method has been used with considerable success in favourable localities.

In Fig. 28, for the reproduction of which we are indebted to Captain Shaw, the curves obtained from a survey over ground known to have a geological structure like that indicated at the bottom of the figure are shown. The times of first arrival of waves at the instruments are shown by the lowest continuous line. For a distance up to about 400ft. from A—the shot point—the surface wave arrived first. But beyond this point the waves travelling through the limestone had a higher velocity and arrived earlier. The time of arrival of the surface waves could still, however, be noted, and the line continuous with the first part of the lower line shows the times of its arrival. On crossing the fault a slight deflection in the lower line occurs, but it is not till the waves have had to travel a distance of 1720ft. from the shot point that another definite discontinuity exists. The line continuing from this point registers the arrival of waves radiating from the upper edge of the limestone-sandstone fault. It will be seen that a thin dotted line nearly coincides with the continuous one. This registers the calculated theoretical time of first arrival for a geological structure like that shown. The lower dotted line, which is drawn to a different scale, records the arrival of the air wave as registered on the instruments.

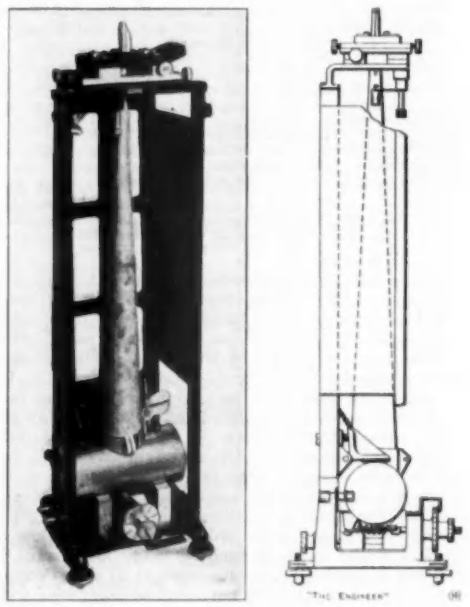


Fig. 29—Microid Vertical Seismograph—Griffin and Tatlock

Instruments.

As a seismic disturbance is an earth movement, it can only be recorded by finding something that is unaffected by the movement of the earth and causing it to record its apparent motion. A pendulum hung lightly from a support fulfils the conditions approximately, since the inertia of the bob is such that it would be "left behind" by the movement of the support, and in consequence, if some recording device was incorporated, a record of the disturbance could be obtained. All modern instruments work on a principle of that nature. A heavy mass, which, owing to its inertia, is unwilling to move, is supported in such a way that its apparent motion can be recorded.

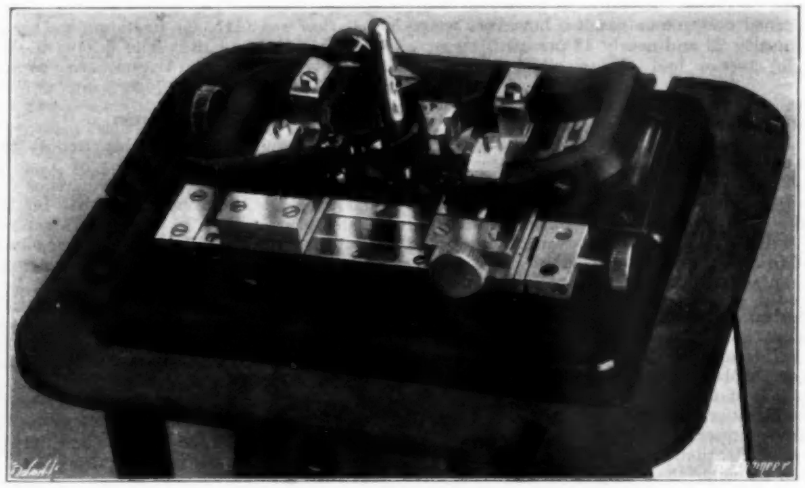


Fig. 30—Upper Part of Microid Vertical Seismograph

In Fig. 29 we reproduce a photograph of the Microid Vertical Seismograph, designed by J. H. Jones, of the Anglo-Persian Oil Company, Ltd., and constructed by Griffin and Tatlock, Ltd., and a drawing of the same instrument is included. The illustration shows the instrument with the protective covers removed. Near the bottom there is a solid lead cylinder, encased in brass, about 15 cm.

* No. III. appeared August 14th.

long and 7·5 cm. in diameter, supported by crossed flat springs, which permit it to turn slightly about its own axis. This is the inertia mass, and its position is controlled by means of the helical spring to be seen below it. One end of this spring is attached to an arm on the inertia mass and the other to a screw

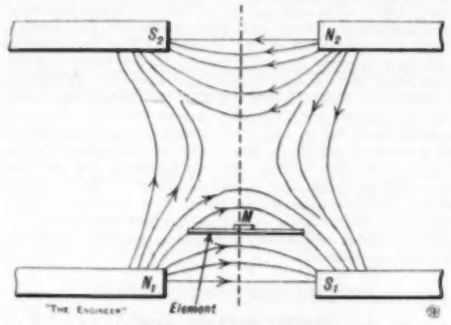


FIG. 31—MAGNETIC FIELD OF MICROID VERTICAL SEISMOGRAPH

operated by the dial in front. A light aluminium cone-shaped helm is fixed to the top of the inertia mass, so that at its upper end the apparent movements of the inertia mass are magnified about eight times. The helm is about 50 cm. long and an oil-damping device controlled by a hand wheel is incorporated. The natural period of this pendulum system is about 0·23 second.

Fig. 30 shows the upper portion of the instrument. The top of the conical helm can be seen projecting through the centre. A phosphor bronze strip is attached to its top and is stretched over two bridges, similar to those on a violin, by means of the adjustable spring to be seen just above the lead weight in Fig. 29. A simple indicating arc registers the tension. Between the two bridges—Fig. 30—there is a small

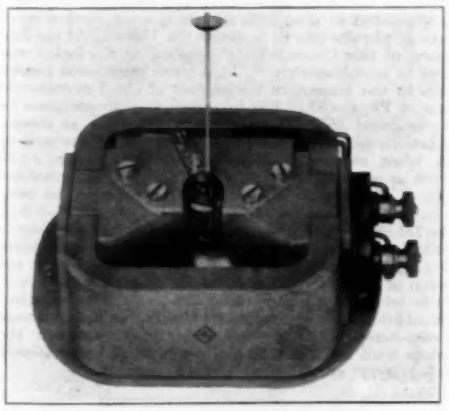


FIG. 33—ELECTRICAL DETECTOR OF THE CAMBRIDGE SEISMOGRAPH

soft iron element carrying a small mirror. This element is situated in the field produced by the magnets on either side of it. By reference to Fig. 31 it will be seen that as the magnets are arranged in opposition a distorted magnetic field exists. The element attempts always to set itself along the lines of force, so that when movement of the helm takes place the element rotates and a beam of light reflected from the mirror carried by the element is deflected. Thus a record of the seismic disturbance can be formed upon a photographic plate. As the magnets are movable, the sensitivity of the instrument can be varied to suit the conditions of the position in which it is placed. For transport the various parts of the instrument can be locked in position, so that no damage can be done by the small accidents that are certain to occur in the field.

A seismograph constructed by the Cambridge Instrument Company is illustrated in Fig. 32. A heavy mass supported on a short lever carried by flexible hinges is balanced by the large spring to be seen below it. A lighter spring for use as a finer adjustment is also provided. The cone helm fitted to the heavy mass carries at its small end a light rod. Referring to Fig. 33, it will be seen that this rod bears upon a small circular plate attached to an armature capable of rotation in a magnetic field. The induced currents set up in the armature by its rotation under the influence of the movement of the heavy mass and the consequent deflection of the helm and the light rod are detected by means of an Einthoven string galvanometer, the terminals of which are connected to the armature by means of the two phosphor bronze hair springs to be seen in Fig. 33.

In the Einthoven string galvanometer a "string" of platinum or plated glass wire is suspended in a strong magnetic field. When a current passes through it the string is deflected in a direction at right angles, both to the magnetic field and the direction of flow of the current. Its movements are recorded photographically by a suitable optical device. An adjustment is provided which enables the tension applied to the string to be accurately controlled. Although this type of galvanometer is less sensitive and somewhat more cumbersome than the moving mirror type, it is said to be particularly suitable for use with seismographs, since it can be designed to have a high string frequency and to be critically damped.

Like the Griffin and Tatlock instrument, the sensitivity of that constructed by the Cambridge Instrument Company, Ltd., is variable at will.

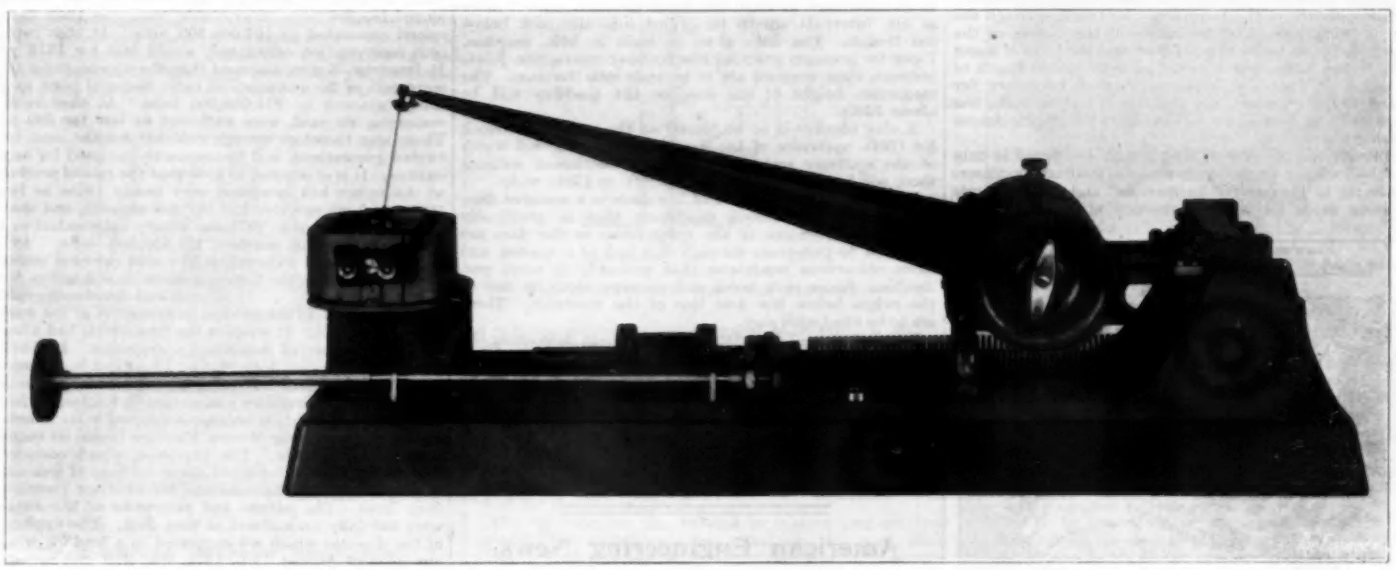


FIG. 32—CAMBRIDGE SEISMOGRAPH

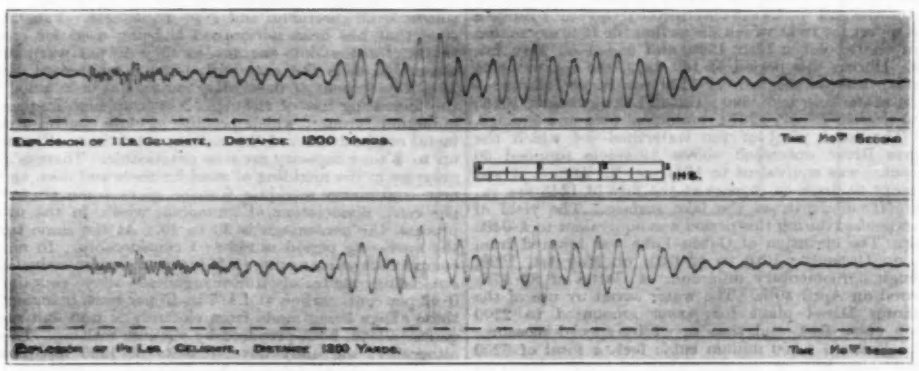

EXPLOSION OF 1 LB. GELIGNITE, DISTANCE 1200 YARDS.
TIME 1/10TH SECOND
INS.
EXPLOSION OF ½ LB. GELIGNITE, DISTANCE 1200 YARDS.
TIME 1/10TH SECOND

FIG. 34—RECORDS OBTAINED WITH CAMBRIDGE SEISMOGRAPH

Fig. 34 is a reproduction of records obtained with this seismograph.

An instrument having a mechanical-optical recording mechanism instead of an electrical one is the Schweydar seismograph, constructed by Askania-Werke A.G., of Berlin-Friedenau. It is made to record either vibrations in both the two horizontal directions and the vertical direction, any two of these directions or any one. For each direction a separate inertia mass has, of course, to be provided. Fitted to the end of the helm attached to each mass there is a light structure in the form of a bow, the string of which is given a turn at its centre around a spindle carrying a mirror. A seismic disturbance causes oscillations of the helm and in consequence rotation of the spindle and mirror.

The Imperial Geophysical Experimental Survey used in Australia an instrument which recorded disturbances in an interesting electrical manner. The inertia mass was arranged as a piston moving in a cylinder fixed to the body of the instrument. Thus when a disturbance occurred air was pumped through a small orifice into and out of the cylinder. A grid of fine platinum wire, normally kept at a dull red heat by the passage of an electrical current, stretched across the orifice, was cooled by the movement of the air, so that it had a variable resistance, and consequently caused a variable flow of current. The oscillations of the current were recorded by an Einthoven string galvanometer.

PRACTICE.

Methods used in the field vary, of course, according to the nature of the terrain and the requirements of the survey. A very usual number of instruments is six, and these can be arranged each to take its own record or each to transmit its electrical vibrations to one string of a multi-string Einthoven galvanometer erected at some central position. Where it can be used, the latter has the advantages of centralised control, while the timing device is the same for each instrument, thus eliminating any errors arising from variations in the timing arrangements of the separate instruments.

The sensitivity of the instruments is set as high as the ground unrest will permit. There are always occurring at any place micro-seisms caused by the wind in the trees, by the movements of animals or minor landslides. Larger seisms are caused by trains and traffic, or the action of a man and a horse ploughing a field. Thus the sensitivity to which an instrument can be set varies from place to place. The amount of explosive it is necessary to use depends partly on the sensitivity of the instruments, partly on the nature of the soil, and partly on the nature of the explosive. Rocks, for instance, readily transmit shocks for long distances, absorbing but little of the energy, while dry sand and clay are bad transmitters, and rapidly absorb it. The I.G.E.S. found that a violent explosion frequently produced a greater effect than a larger charge of more powerful but less explosive material. When used on the surface the efficiency of the transmission of the shock caused by

the explosion to the ground is much less than when the charge is buried. At the same time, explosive used on the surface usually forms a crater, while, providing proper precautions are taken and the ground is suitable, a buried charge need do no more than lift the soil and let it drop back into position again with very little surface disturbance.

The moment at which the explosion occurs is of considerable importance if the wave velocity is to be accurately determined. At first it was estimated from the time of arrival of the air wave, but this method was too unreliable, and it is usual nowadays either to send out a wireless signal at the time the charge is fired or to arrange a wire passing through the charge, which is broken by the explosion, and thereby breaks an electrical circuit.

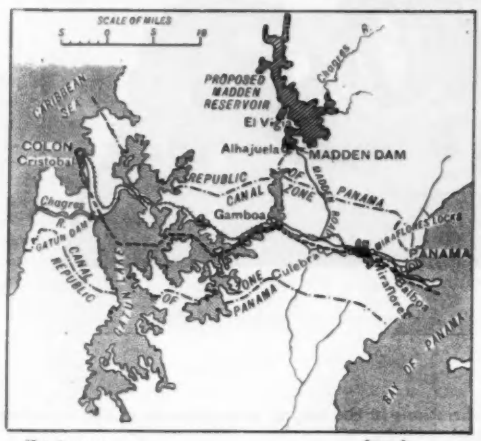
(To be continued.)

Panama Canal Developments.

It has just been reported that estimates for the construction of a new dam for ensuring the extended supply of water for the working of the Panama Canal have been invited by the Government of the United States of America, and as the matter is of some international importance, we reproduce herewith a map of the project, published by our contemporary *The Engineering News-Record*, of New York, together with an excerpt of an article in that journal describing the project.

The necessity for this additional storage of water to meet times of low rainfall was appreciated by the engineers of the French scheme for a canal, and it has now been decided by the owners of the canal that such a programme must be followed out. At present the traffic through the canal is being carried on by means of the waters of the Chagres River in times of good flow, and the level of water in the Gatun Lake, which forms an appreciable length of the canal, is generally kept up to that necessary for floating the craft which use the canal, but recourse has occasionally to be had to the auxiliary oil engine-driven pumping plant.

Although the present traffic through the canal is only about half what it might accommodate, the State engineers are aiming to provide for an increase, and arrangements are being made for a supplementary storage dam over



PROPOSED MADDEN DAM

and above—the words are deliberate—that given by the Gatun Lake.

The idea is to dam the Chagres River near the village of Alhajuela, and there to build the Madden dam, so that the flood waters of that river need not be wasted in the sea, but may be used for both power and navigation purposes on the canal. Incidentally, there will be the possibility of developing about 24,000 horse-power. The scheme and works are described by Governor Burgess in his report for 1930, which shows that the 1930 dry season began on December 13th, 1929, and ended on May 1st, 1930. During this period of 140 days, the consumption of water was at the rate of 3169 sec.-ft. as follows:—Evaporation from lake, 800; Gatun Lake lockages, 1025; hydro-electric power, 1287; municipal uses and leakage, 57. The total yield of the watershed—of which the Chagres River watershed above Alhajuela supplied 59 per cent.—was equivalent to 1524 sec.-ft. Hence, it was necessary to draw on storage at the rate of 1645 sec.-ft., or 4·36ft. of depth on the lake surface. The yield of the watershed during this period was equivalent to 4·04ft. depth. The elevation of Gatun Lake was lowered from 87ft. on December 13th to 82·64ft. on May 1st, 1930, although a momentary minimum at Gatun of 82·57ft. occurred on April 30th. The water saved by use of the Miraflores Diesel plant for power amounted to 2200 million cubic feet, and that saved by special measures at the locks to 4,000 million cubic feet, a total of 6200 million cubic feet, or the equivalent of 1·36ft. depth on Gatun Lake. Had there been no saving of water, the minimum elevation of Gatun Lake would have been 81·28ft. instead of 82·64ft.

The quantity of water available for lockages during a typical dry year is 31 billion cubic feet. This is sufficient for thirty-two lockages per day during the period when it is necessary to draw upon storage. The average number of lockages in 1928—the peak year—was 16·7. Colonel Burgess estimates that in order to avoid congestion on peak days a third set of locks and an additional water supply should be available when the average number of lockages reaches twenty-seven per day. By the construction of a reservoir above Alhajuela the lockages can be increased to sixty per day.

However, the additional supply to be provided by the new reservoir on the upper Chagres River will be needed in advance of the construction of the third set of locks in order to keep the depth of water in Gaillard Cut from becoming less than 42ft. to 43ft. Also, it is necessary to reduce the interruptions to canal traffic due to floods and to provide more water for hydro-electric power, thus saving on the cost of operating the Diesel-electric power plant. During eight months of the year much excess water enters Gatun Lake and has to be spilled into the sea. During the remaining four months the inflow is wholly inadequate to meet the demands for water for lockages, generation of power and municipal purposes in addition to the heavy losses resulting from evaporation. The maximum height to which Gatun Lake may be filled is 87ft. The minimum lake elevation permitting safe navigation through Gaillard Cut is 80ft. This gives a margin of 7ft. of storage available for drawing upon during the dry season.

Construction of the Madden reservoir to provide added water, and the construction of a concrete road from the Canal Zone up to the site of the proposed dam, were authorised by Congress in 1928. The normal surface is to be held as close as possible to El. 240, or 140ft. above low water in the river. This gives a reservoir capacity of 22,056 million cubic feet—506,000 acre-ft. The permanent crest of the dam is to be at El. 232 and drum gates 100ft. by 18ft. on the spillway crest will be used to hold the reservoir level at El. 250. Estimates of the run-off indicate that the 1000-year flood will raise the reservoir to El. 263. At that level 12,000 million cubic feet of storage will be available for flood control.

The concrete portion of the main dam will be about 900ft. long. Of this, 436ft. will be a spillway section, and the remainder a bulkhead section. Intake works, penstocks and control valves for a power-house are to be built into the bulkhead section at the south side of the river. Excavation for the base of the dam is to be carried well into solid rock and a cut-off trench is to be excavated beneath the upstream heel. Grout holes at 5ft. intervals are to be drilled into the rock below the trench. The dam is to be built in 56ft. sections. Pipes for pressure grouting the vertical contraction joints between these sections are to be built into the dam. The maximum height of the dam to the roadway will be about 220ft.

A clay blanket is to be placed on the stripped bedrock for 150ft. upstream of the dam for almost the full width of the spillway section; above the abutment sections there will be concrete blanketing, 20ft. to 150ft. wide.

The bedrock at the site of the dam is a massive fine-grained grey calcareous sandstone that is practically impermeable. Some of the grout holes at the dam are expected to penetrate through this bed to a coarser and more calcareous sandstone that probably is more permeable. Some sink holes and caverns occur in one of the ridges below the flow line of the reservoir. These are to be filled with clay.

Earth Dams.—The extension of the main dam along the ridge to the south is to be embankment, part dumped rock and part rolled earth and gravel, with concrete paving on the upstream face, topped with a 3ft. parapet. This structure will have no corewall. The thirteen saddle dams will be of similar character, but without concrete paving. Only one of them, a high one to close off the side valley coming in below the main dam on the north side, is to have a corewall.

American Engineering News.

Iron and Steel Alloy Developments.

During 1930, American metallurgical work included increased production of corrosion-resisting austenite chromium-nickel steels, while a steel having 18 per cent. chromium and 8 per cent. manganese was developed. It has electrical characteristics and other properties very similar to those of chromium-nickel steel. In stills for oil cracking the high-chromium steels are desirable, owing to their resistance to corrosion and pressure, having from four to ten times the life of mild steel at only double the cost. But tubes with 16 per cent. chromium become brittle at high temperatures unless they have also about 8 per cent. of nickel. Nickel and nickel-chromium steels containing molybdenum are being used for heavy forgings. Another combination, that is used for oil-well casings, contains 0·40 per cent. carbon, 0·85 silicon, 0·50 chromium and 1·10 manganese. Vanadium steel that has been normalised is being used for crank shafts of automobile engines, as they do not warp after assembly, as is the case with much heat-treated steel. The development of these alloy metals has been aided by the increasing use of the Ajax-Northrup high-frequency induction furnace, which permits of close control of the metal composition and the melting conditions. Furnaces up to 3 tons capacity are now practicable. There is also progress in the nitriding of steel for tools and dies, and a new continuous nitriding furnace gives some 80 to 95 per cent. dissociation of ammonia, while, in the usual process, the percentage is 30 to 40. At the same time, the operating period is reduced considerably. In many complex alloys manganese is being used, and investigations are being made of iron-manganese alloy containing 0·02 per cent. carbon and 1·7 to 15 per cent. manganese, these alloys being made from electrolytic iron and manganese alloys, both prepared by vacuum melting. Taken altogether, the alloy developments of 1930 have been numerous, varied and of high commercial importance.

American Permanent Way Developments.

The proceedings at the annual meeting of the American Railway Engineering Association constituted a review of improvements and developments in permanent way construction and maintenance. Much attention is being given to washed, screened and graded gravel ballast, while the standard specifications for ties, or sleepers, are becoming used almost universally. The use of treated ties is also increasing rapidly. Records now available indicate an average life of 20 to 25 years, but few railroads have as yet reliable records for such a period, so that, with further experience, the average may be found nearer 30 years. Although various kinds of steel and concrete ties have been tried experimentally, few, if any, have been placed within the past two or three years, and those already in place are gradually disappearing. Increase in weight of rails has reached a maximum—for the present—of 152 lb. per yard in 8in. rails for the Pennsylvania Railroad. Rails of intermediate or medium manganese steel are increasing in favour, while the experimental heat-treated rails are proving satisfactory as to service, but the cost is very high. The rails are inverted, the heads quenched by immersion in water, and then immersed in a bath of molten lead to equalise the stresses. For investigation of stresses in rails and rail joints, under traffic, instruments have been designed to record these stresses during the passage of fast and heavy rails. Of special importance is an agreement between the Association and the steel manufacturers for co-operative study of rail manufacture with a view to producing steel of higher and more uniform quality, and with better wearing qualities for the very heavy rolling stock and wheel loads of modern railway traffic. Attention is being given also to the value of deeper and stiffer rails to act as girders and reduce the deflection under such heavy loads, thus materially reducing the train resistance.

SIXTY YEARS AGO.

In 1866 some alarm was felt at the rapidity with which this country was increasing its annual consumption of coal and at the possibility that in the not distant future our coal resources would be exhausted. A Royal Commission on the subject was appointed. It went very thoroughly into the question; so thoroughly, in fact, that it did not issue its report until five years afterwards. In our issue of August 25th, 1871, we summarised its findings. The Commissioners reported that, taking 4000ft. as the practical limit of depth of working, our coalfields still contained 90,207,285,398 tons of available coal. In 1869 the coal mined amounted to 107,000,000 tons. At that rate our coal reserves, we calculated, would last for 1273 years. If, however, it were assumed that the consumption of coal increased in an arithmetical ratio the coal used in 1971 would amount to 274,000,000 tons. At that rate our resources, we said, were sufficient to last for 360 years. There was therefore enough coal left for the next ten or twelve generations, and consequently no need for anxiety existed. It is of interest to note that the rate of production at the mines has increased very nearly twice as fast as that which we employed in our calculations, and that the anticipated output in 1971 was closely approached in 1929 when the output reached 268,838,000 tons. At this increased rate of exhaustion the coal reserves estimated to be available by the Commissioners should last us for the next 160 years. . . . A great and disastrous explosion of gun-cotton had occurred at Stowmarket at the works of Prentice and Co. It was not the first which had attended the manufacture of Schönbein's explosive. In 1847 the Faversham works of John Hall and Sons had been destroyed by an explosion which acted as a deterrent for a number of years to further work on gun-cotton in England. In 1863 the British Association became interested in the substance, and in the same year Messrs. Prentice began its manufacture at Stowmarket. The explosion which occurred on August 14th, 1871, involved about 15 tons of gun-cotton. Among others, Mr. Edward and Mr. William Prentice lost their lives. The nature and properties of the explosive were not fully understood at that date. The explanation of the disaster which we suggested in a leading article in our issue of August 25th, 1871, was that gun-cotton was liable to deterioration from causes that were then unknown. The Home Office inquiry into the accident did much to support that view. In the following year the manufacture of gun-cotton was begun at Waltham Abbey, and in 1875 the Explosives Act was introduced.

INTERNATIONAL UNION OF PHYSICS.

At the recent meeting of the International Union of Physics, held at Brussels on July 12th, 1931, among other matters brought forward by the British National Committee was the suggestion that the Union should define the unit of heat. As the result of a discussion in which a number of members took part, a "Sous Commission" was appointed to deal with symbols, units, and nomenclature in physics and to report to the Union. At the first meeting of this Commission the following resolution was agreed to unanimously:—"That this Commission recommends to the Executive Committee of the International Union of Physics that the following two propositions be communicated to the next General Assembly as recommendations from this Committee:—(1) That the unit of heat, when measured in units of energy, be the Joule defined as equivalent to 10^7 ergs; (2) that the gramme-calorie is the amount of heat required to raise the temperature of 1 gramme of water from 14·5 deg. to 15·5 deg. of the International Scale of Temperature." According to existing measurements, the gramme-calorie is equivalent to 4·18 (6) Joules. The definition is consistent with the decision of the International Steam Tables Conference in 1929 to adopt as a unit suitable for its purpose an international kilocalorie equivalent to 1/860 of an international kilowatt-hour, the difference being that between the absolute watt and the international watt (1 international watt = 1·00039 absolute watts).

IRON AND STEEL PRODUCTION IN JULY.

The number of blast-furnaces in operation in this country at the end of July was seventy, a net decrease of six since the beginning of the month, three furnaces having been damped down, four blown out, and one having resumed operations. The production of pig iron amounted to 317,000 tons, compared with 323,800 tons in June and 486,100 tons in July, 1930. The production included 77,300 tons of hematite, 116,700 tons of basic, 95,300 tons of foundry, and 14,500 tons of forge pig iron. The July output of steel ingots and castings amounted to 428,700 tons, compared with 428,900 tons in June and 621,400 tons in July, 1930.

An Automatic Regulator.

A REGULATOR which works without vibrating contacts and is capable of producing considerable mechanical force in direct proportion to variations in voltage current, power factor, &c., is being manufactured by Isenthal and Co., Ltd., of Duncan Works, North Acton, W. 3.

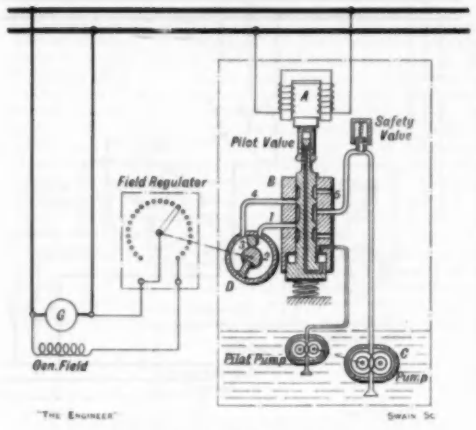


FIG. 1—D.C. GENERATOR CONTROL

Its design resembles that of a hydraulic turbine regulator, but the centrifugal governor is replaced by an electro-magnetic control device. Recently, the apparatus has also been utilised for regulating liquid and gas pressures, and in these cases the control device takes the form of a

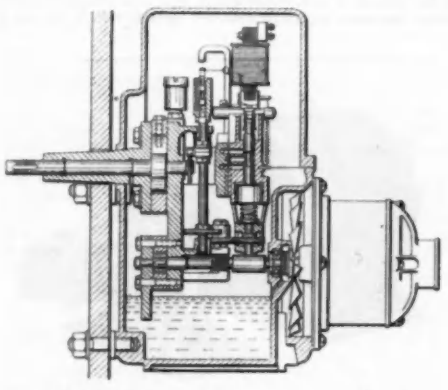


FIG. 2—SECTION THROUGH REGULATOR

Bourdon gauge. In all cases, however, a servo motor, working with a liquid medium, is used and provides the mechanical force without introducing appreciable inertia, and an extraordinary degree of accuracy and rapidity of regulation is said to be assured.

The diagram, Fig. 1, shows the apparatus applied to

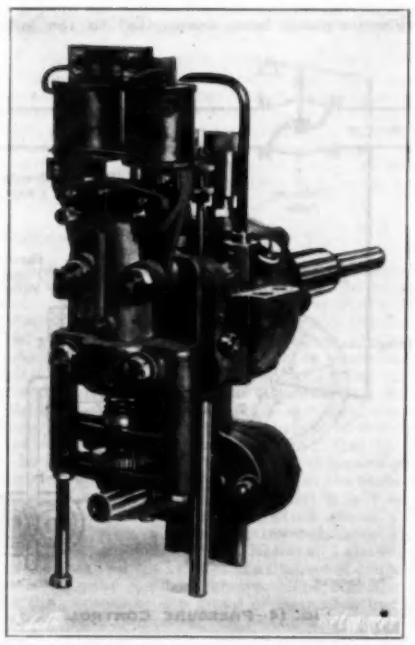


FIG. 3—REGULATOR REMOVED FROM CASE

the regulation of a D.C. generator. Across the mains or the terminals of the generator an electro-magnet A is connected and between its poles a spring-controlled armature moves. Directly or indirectly the armature operates the slide valve of a hydraulic system and controls the supply of oil, which an oil pump C forces into the servo motor, constructed on well-known lines with a single wing rotating in a cylindrical housing. If the voltage of the generator drops the pull on the armature is reduced and the slide valve moves downwards. The oil then enters the tube 1 and space 2, while the oil in the space 3 can escape by way of the tube 4 and aperture 5 back into the oil reservoir. The result is a displacement of the servo motor wing in a clockwise direction, and the lever of the field resistance coupled to it is moved so as to reduce the field resistance. The resulting higher voltage causes the magnet A to pull the armature and distributing slide upwards, and as soon as the voltage attains its normal value the armature and slide take up the mid position and no further regulation occurs. The electrical portion of the apparatus is extremely simple, and since the whole

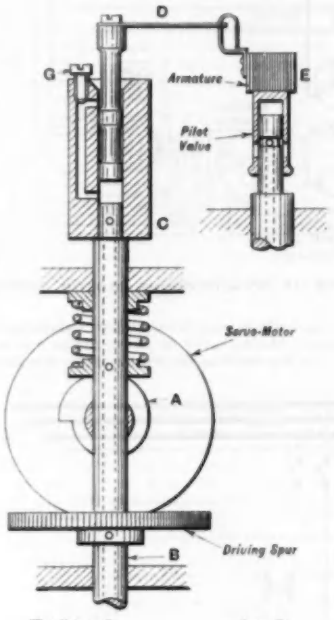


FIG. 4—VOLTAGE LIMITING MECHANISM

of the mechanical equipment works in oil there is practically no friction, and the parts are not subjected to wear. The oil pump, which like the remainder of the equipment, with the exception of the magnet, is enclosed in a substantial oil tank, is usually driven by an electric motor directly attached to the casing. The pilot pump shown in the drawing has been abandoned. As the pump C only provides the full oil pressure during the periods of actual regulation, it requires very little energy to drive it. If more convenient, a belt drive from a shaft may be substituted for the motor drive.

The regulator can also be used for maintaining constant current; for transformer tap changing; for controlling series or load resistances; for controlling induction regulators, or the electrodes of electric furnaces; for adjusting the capacity of condensers for power factor correction, or for regulating the supply of water, steam or fuel for prime movers by acting on the throttle, or by changing the angle of the guide blades. The magnet or magnets of the control system have a very small air gap, so that a considerable magnetic pull is produced with a small amount of energy. Even when the armature displacement is in the neighbourhood of 0·01 mm. to 0·1 mm., regulation begins, and owing to the magnitude of the magnetic pull and the small mass to be moved, the regulation takes place very rapidly, and in the case of variation in load the regulating movements begin before the voltage fluctuation has had time fully to develop.

The size of the servo motor determines the torque available for operating resistances, &c., and in the case of the small types, J 8—see Figs. 2 and 3—the shaft of the servo motor can turn through 300 deg. in 1·3 seconds, and twice that time in the case of another type designated E 4. Both these regulators are suitable for resistances carrying currents up to 200 ampères. In the case of the still larger types, the angle through which the servo motor turns is about 70 deg., and much larger torques are obtainable with these regulators. For the largest regulators a servo motor of the piston and cylinder type is used. By simply turning a by-pass tap, which can be operated on the remote control system, the servo motor and the mechanism operating it can be put out of commission. The oil pumps are valveless, with hardened and ground gear wheels and shafts, which are immersed in oil. Another important feature of the regulator is the back coupling, which is necessary on account of the fact that changes in the flux of a generator and, therefore, changes in the voltage, do not occur in phase with the

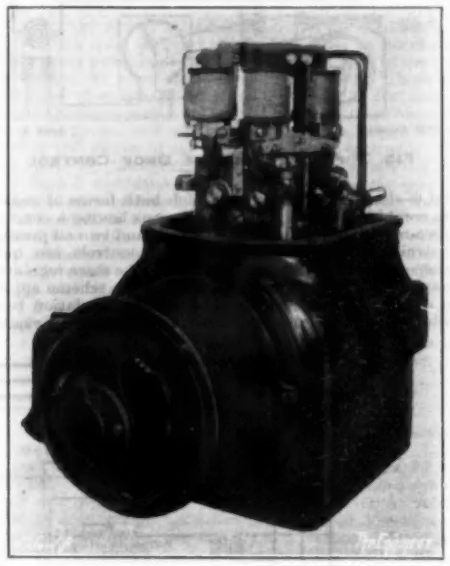


FIG. 6—VOLTAGE AND CURRENT REGULATOR

movement of the field regulator, but, owing to the magnetic inertia of the field are more or less lagging behind the regulator movement. In order to bring the voltage back rapidly, incidental to a load peak, it is necessary that the movement of the field resistance should provide for "over-shooting," and this is effected by means of the cam A—Fig. 4—mounted on the shaft of the servo motor. By means of this cam the vertical spindle B, which is rotated by spur wheels, is shifted vertically. Its upper end is connected over an oil damping device C to a flat spring D, which, in turn, engages with the armature of the electro-magnet E. When the voltage drops the armature sinks in the ordinary way, and the servo motor turns in a clockwise direction. Thus, by means of the cam, it lifts the flat spring D and acts upon the armature so that its movement is interrupted after sufficient over-shooting

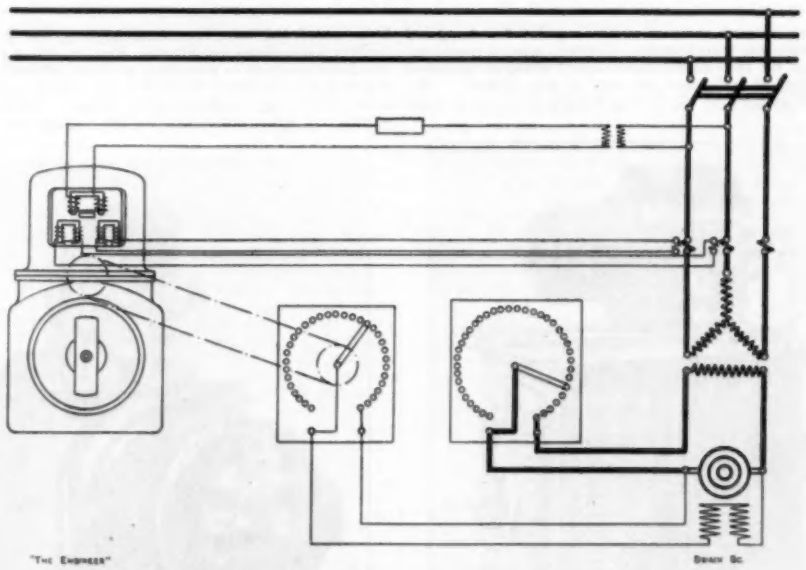


FIG. 5—VOLTAGE AND CURRENT CONTROL

has taken place. If, now, the voltage rises, the regulator assumes a new stable position, corresponding to the new working conditions. The oil damper has an adjustment G to regulate the degree of coupling between the vertical spindle and the piston carrying the flat spring, and since the damping arrangement is continually rotated, no undesirable influences, such as friction, thickening of the oil, or sticking, can occur.

As we have said, the regulator can be modified to keep the current of the installation at a constant value, and in this connection it may be used to protect generators against overloads and short circuits. The makers point out that by reducing the excitation and thus lowering the voltage considerable advantages are obtained over the method of tripping the oil switch. Although the excitation is reduced, the plant remains in operation without risk of damage,

and when the overload is removed normal conditions are automatically restored. If a short circuit is of considerable duration and is sufficiently severe the switch will trip, but owing to the reduction in the excitation the energy that has to be dealt with by the switch is much less than usual.

Since this form of protection is generally used simultaneously with voltage regulation, a regulator—see Figs. 5 and 6—has been designed in which both forms of control are combined in one piece of apparatus having a common servo-motor, but two electric controls and two oil pressure control valves. Although the two controls are quite independent of each other, they act on the same regulating resistance. The diagram Fig. 5 shows the scheme applied to a three-phase generator, the voltage regulation being obtained by a variable resistance in the field of the exciter.

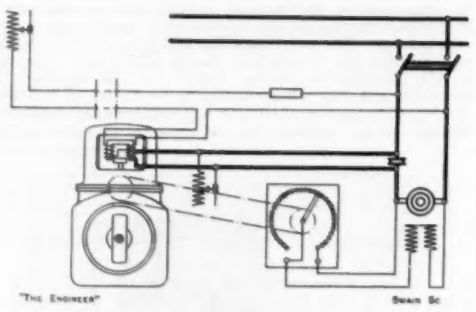


FIG. 7—FEEDER VOLTAGE DROP CONTROL

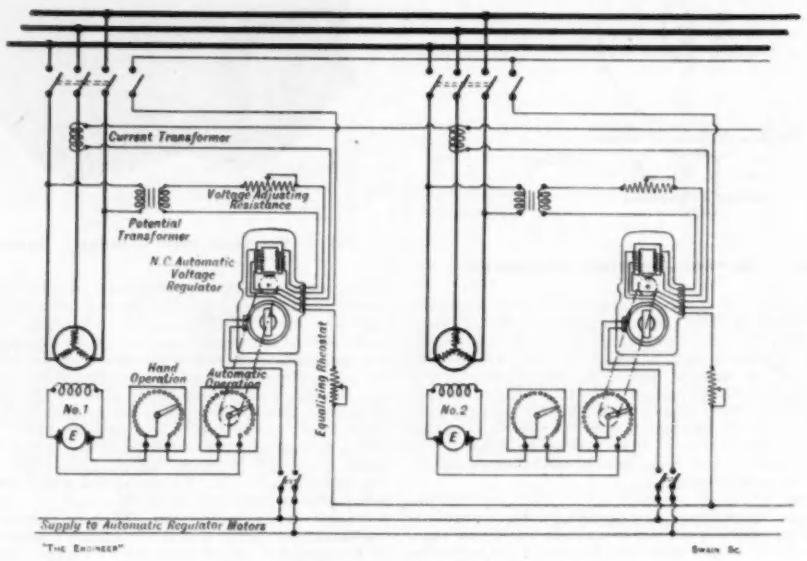


FIG. 8—ALTERNATOR EXCITATION CONTROL

The voltage control magnet of the regulator is supplied from a potential transformer. Control against overload is provided by two additional magnet systems supplied from current transformers in two of the phases. The same servo-motor and regulating resistance serve in both cases, and the operating current is adjustable between 20 per cent. and 80 per cent. excess current. The regulating resistance on the right of Fig. 5 is a hand regulator.

As the regulator is essentially a sensitive mechanical relay, by means of which very minute forces in the neighbourhood of one gramme or so are amplified up to several tons, it is obvious that the apparatus can be used for many purposes. As we have indicated, several control elements may be made to act on one servo-motor which may operate series or shunt resistances regulating transformers, loading resistances, turbine and Pelton wheel valves, and switches for adjusting the capacity of power factor condensers, &c. In Fig. 7 a regulator is shown arranged for controlling a D.C. generator and for compensating the drop in the feeders due to load variations. For the latter purpose the regulator magnet is provided with an additional current winding supplied from a shunt in the feeder, and a diverter is provided to give adjustment. Another refinement is an additional series resistance in the voltage winding, permitting the remote control of the regulated voltage. The diagram Fig. 8, which is self-explanatory, shows the application of these regulators to the control of the excitation of parallel-operated alternators, whilst Fig. 9 shows a regulator arranged for operating the exciter field rheostat of a turbo-alternator set, but it should be mentioned that the equipment can also be arranged for switchboard

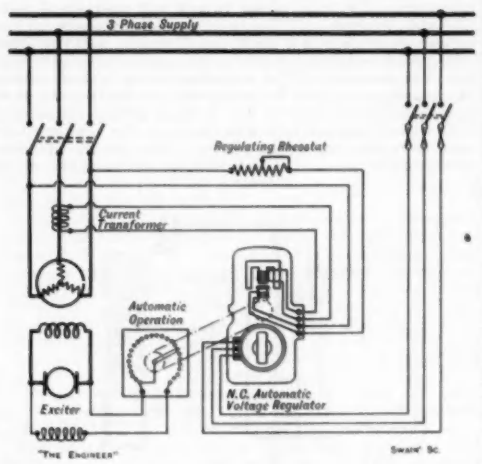


FIG. 10—SYNCHRONOUS MOTOR CONTROL

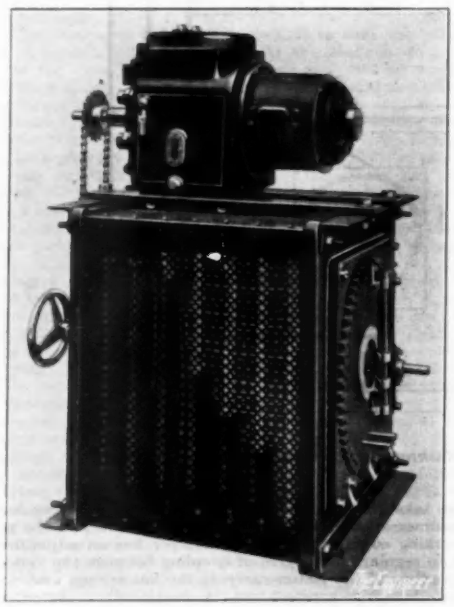


FIG. 9—REGULATOR OPERATING RHEOSTAT

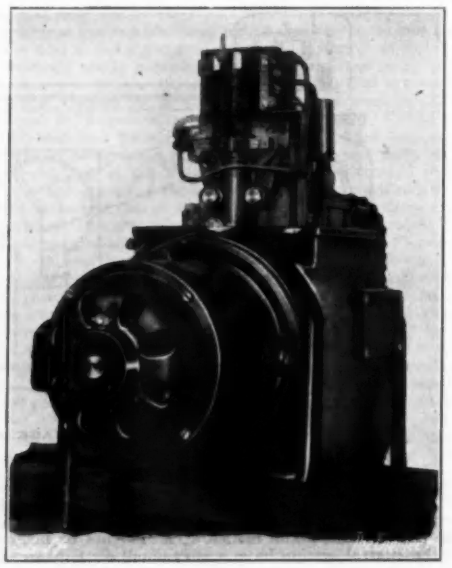


FIG. 11—POWER FACTOR REGULATOR

mounting with the rheostat box at the back of the panel. The diagram Fig. 10 shows how a regulator may be used for regulating the excitation of a synchronous motor for power factor improvement, whilst a regulator for this purpose, which may be used equally well as a master switch for controlling a bank of condensers for the same purpose, is shown in Fig. 11. When regulators are used for controlling a battery of condensers for power factor

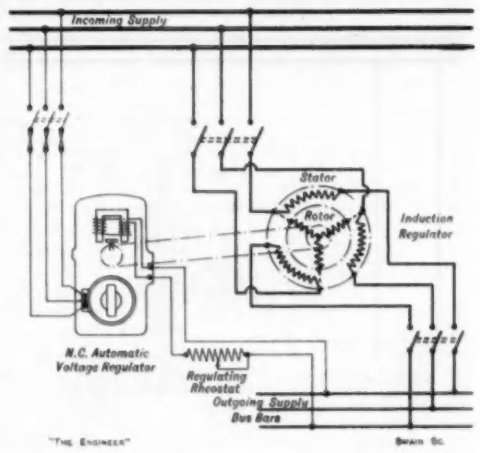


FIG. 12—INDUCTION REGULATOR CONTROL

improvement the armature of the standard regulator is replaced by a balanced and floating coil, which is connected across two of the three-phase mains, whilst the fixed magnet is fed from a current transformer in another phase. At unity power factor the armature is in equilibrium, whilst any deviation from this condition results in a movement of the armature and consequent action of the servo-motor which operates a group selector switch which serves for inserting more or fewer condenser units, thereby keeping the power factor approximately at unity for any load.

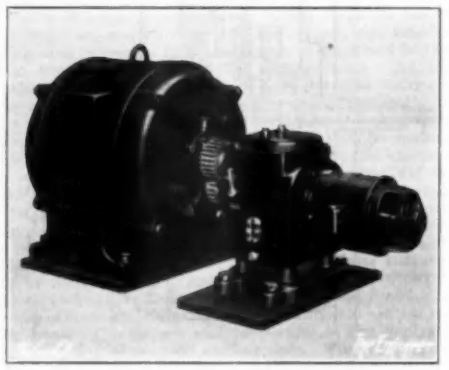


FIG. 13—INDUCTION REGULATOR AND CONTROL UNIT

The rapid automatic operation of induction regulators in accordance with voltage is a difficult problem, as considerable force is needed to turn the moving part. The type of regulator under consideration, however, is claimed completely to remove the difficulties, the motion of the servo-motor piston being transmitted to the induction regulator as shown in Fig. 12. In the case of horizontal induction regulators the two units are mounted as shown in Fig. 13. The regulator controlling the induction regulator is arranged to work with progressive regulating speed, small variations being dealt with slowly and large variations very rapidly, and there are no shocks. The adjustment of the voltage to different values as needed in practice within ± 10 per cent. of the standard voltage is effected by varying the resistance supplied.

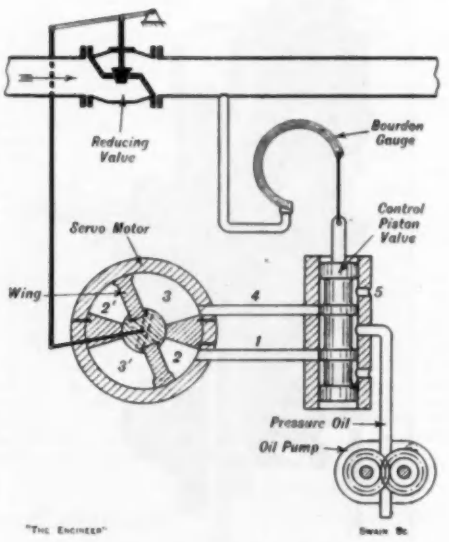


FIG. 14—PRESSURE CONTROL

The modified form of the regulator for keeping constant or varying in accordance with requirements the pressure of a liquid or a gas involves the use of a Bourdon gauge, as shown in Fig. 14. Obviously any change of the curvature of the Bourdon tube gives rise to a vertical movement of the control piston valve, which in practice is kept in continuous rotation in order to reduce friction to a minimum, and the oil provided by the gear pump is controlled on its way to the servo-motor, which operates the regulating shaft. If for any reason the pressure behind the reducing valve drops the tension in the pressure gauge is reduced and the piston connected to the Bourdon tube moves downwards. The oil then passes through the tube 1 into the pressure space 2 of the servo-motor and through the hole in the regulator shaft into the pressure space 2^1, whilst the oil contained in the space 3 and 3^1 escapes through the tube 4 into the piston casing and out through the channel 5 back into the oil container. As a result the regulating shaft is turned in a clockwise direction and by means of the system of levers shown increases the opening of the reducing valve, thereby re-establishing the necessary pressure. In order to eliminate the time lag which is liable to occur whilst the pressure sinks, this regulator is also provided with an elastic back coupling which gives a certain amount of "overshoot" in the regulation, thus re-establishing the normal pressure rapidly without hunting. The speed of regulation is proportional to the movement of the control piston, and therefore increases steadily with the divergence between the actual pressure and the requisite pressure.

Canadian Engineering News.

Gold Recovery Experiment.

An experimental testing plant, of 200-ton capacity, designed to recover gold losses in the tailings, is now being installed at the Lake Shore, premier gold mine of the Kirkland Lake area. The process, which is more or less secret, has been thoroughly tried on a laboratory scale, and, by erecting a mill of such size, the American Cyanamide Company, which is behind the project, is apparently confident that it will prove commercially successful.

Aviation Progress.

Aircraft in Canada in the year 1930 flew 7,547,420 miles, which was 1,263,000 miles more than in 1929, and almost 5,000,000 more than in 1928. There was a slight increase in the number of passengers carried, 124,875 being the figure for last year, as compared with 124,751 in 1929 and 74,669 in 1928. This advance was achieved despite a reduction of 9000 in the number of light airplane club members carried on dual instruction, only 11,784 having been recorded for last year in that category.

Storage of Natural Gas.

Proposals to store vastly greater quantities of natural gas in the sands of the Bow Island field, 140 miles south-east of Calgary, Alberta, have been disclosed by C. J. Yorath, managing director of the Canadian Western Natural Gas, Light, Heat and Power Company. In July last year the company started the experiment of forcing surplus natural gas from the Turner Valley field into the depleted sands of the Bow Island field. That the experiment has met with success is indicated in Mr. Yorath's statement that the gas company is proposing to treble the capacity of the re-pressuring plant at Bow Island with the object in view of storing about 15,000 million cubic feet of gas within the next ten years. The company has already stored 1200 million cubic feet of gas. The reserve of gas in the Bow Island field at the present time is estimated at 7000 million cubic feet.

Royal Society Annual Meet.

Sir Robert Falconer, President of the University of Toronto, was elected President of the Royal Society of Canada at the annual meeting in Toronto recently. On recommendation of the Executive Council, the constitution of the Society was amended so as to permit a Fellow leaving Canada to retain his full privileges. It was pointed out that as a result of the old ruling, the Society had lost many distinguished scientists, such as Sir Ernest Rutherford.

National Research.

Quite a remarkable reaction from the depressed state of industry during the past year was the increased demand made upon the National Research Council's laboratories. Never before had the officers of the Council received so many requests for assistance in the utilisation of waste products, the standardisation of products, and in other efforts of economy and efficiency. In the minds of those who conceived the National Research Laboratories has been the idea that in them could be combined the principles on which the United States Bureau of Standards and the Mellon Institute have operated; that is, they would be prepared to conduct researches of general public interest and therefore at the full expense of the State, and researches of more restricted and special benefit at the expense of private companies who would contribute to the cost of the work or have their research investigators work on their problems in the National Laboratories. During the past year the interest of a number of companies in the latter plan has been shown. The contributions toward the expense of one group of researches has been doubled by those interested. Of recent date, one of the Maritime Provinces signified its intention to place an investigator in the Council's laboratories at its own expense.

Market for British Steel.

There is a very strong belief in Canadian industrial circles that as a result of the recent visit of Julian I. Piggott, manager of the British Steel Export Association, definite, concrete agreements between the Association and Canadian firms will be formulated within the next few months. Sales of British steel to Canada this year should be far in excess of those for 1930 and 1929, the only years with which any comparison might be made, as no previous concerted effort had been made to develop the Canadian market. Heavy steel beams and structural sections and plates over 60in. in width are not constructed or rolled in Canada. These are the products that the British Steel Export Association are anxious to sell in Canada, capturing this market for such sizes from the United States.

New Sulphur Producing Plant.

Marking another milestone in Canadian mining history, ground was broken recently for the concentrator of the Aldermac Mine, 10 miles west of the Noranda plant, in the province of Quebec, where deposits of sulphur, which are now commercially important through a new process of roasting the ore, are expected to supply a large Canadian demand which hitherto has been supplied exclusively by the United States. Canadian paper mills especially are large users of sulphur, and for many years have been supplied with Texas brimstone. With the perfection last year of a new type of roaster, pyrite ores can now be successfully treated to produce a quality of sulphur equal, if not superior, to the European. An expenditure totalling 400,000 dollars is contemplated at the Aldermac property with the construction recently started, the programme including office buildings, pumping station, filtering and drying plants and railway facilities, as well as the concentrator, which is the major building. A mill capable of about 500 tons a day will be immediately installed, but its design will allow expansion to 1000 tons daily on short notice.

Huge Sewage Project.

As much as 20,000,000 dollars may be required to give the city of Toronto a new sewage treatment system which would provide for the whole city, exclusive of North Toronto. City Council recently took action in the direction of providing the new works, when experts were appointed to go thoroughly into the whole situation. The Canadian firm of Gore, Nasmith and Storrie, of Toronto, will have associated with them Mr. Harrison P. Eddy, of the firm of Metcalf and Eddy, consulting engineers, of Boston, U.S.A.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Apathetic Conditions.

INDUSTRIAL activity in the Midlands and Staffordshire does not increase, and there is no apparent improvement in trading conditions. The outlook is so uncertain that industrialists cannot plan ahead, and though they believe that the country is moving in the right direction and that there are better times in store, they can do nothing until they know what they, in common with all others, have to face. Attendance on 'Change in Birmingham this week has been poor, and only small-scale business has rewarded those who put in an appearance. In some cases principals are still on holiday, and not all the works have as yet resumed operations after the holiday break. It is expected that even the worse-situated firms will be opening up on Monday, though it is improbable that a full working week will be possible for many of them. The general trade position in the Midlands and Staffordshire is deplorable.

Pig Iron.

Last week's improvement in buying of pig iron has not been maintained. Midland consuming industries, having bought sufficient for current needs, are taking no further active interest in the market. Reports from the foundries and forges in the district continue discouraging. Fresh business is imperative if activity is to be maintained. That consumptive demand is still shrinking would appear to be borne out by the fact that although production of pig iron last month only amounted to 317,000 tons, compared with 323,800 tons in June, stocks at the furnaces have increased rather than diminished. It is an unpleasant commentary upon the state of the industry that there are six furnaces less in operation than there were a month ago, and that there are now only seventy active blast-furnaces in the whole of England. Derbyshire and Northamptonshire smelters are receiving small orders from the Midlands, and the latter are meeting with some success in northern markets. Heavy stocks are causing them some concern, and there are ironmasters who are said to favour the experiment of a lower range of selling prices. Consumers cannot guarantee that they would be able to take larger supplies, even if prices were reduced, so that there seems to be little probability of a move in this direction. The Central Pig Iron Producers' Association requires that Midland irons should be sold in this zone at £3 2s. 6d. for Northamptonshire No. 3 foundry, £2 17s. 6d. for forge, £3 6s. for Derbyshire and North Staffordshire No. 3 foundry, and £3 1s. for forge—all delivered at stations in the Black Country.

Steel.

The steel market remains sluggish, and little interest is evinced in prices. In the case of finished material values are upheld by combination, while in the semi-finished department prices have sunk so low in an effort to combat foreign intrusion that they cannot very well sink lower, and while foreign steel is offered at to-day's rates local steelmasters can hardly increase the quotations for their productions. Midland structural engineers continue to place contracts, but specifications against them are small. There is, however, slightly more activity in this branch than of late. The level of prices fixed by the Steelmasters' Association is strictly adhered to. Angles are £8 7s. 6d., tees £9 7s. 6d., joists £8 15s., ship, bridge and tank plates £8 17s. 6d., each less their respective rebates. Boiler plates command £9 per ton; small bars, re-rolled from continental material, £6 7s. 6d. to £6 10s.; all-British bars, £7; mild steel billets, £5 upwards; and Staffordshire hoops, £9 10s. Local works maintain an indifferent attitude towards the very low offers now being made of foreign steel. Billets were procurable in Birmingham this week at slightly more than £4 per ton; steel bars were quoted £4 2s. 6d., and small steel bars at round about £4 8s. 6d. Consumptive demand for all steel materials remains unsatisfactory. Recent production figures show that there is little variation in the quantity of steel being called for. Output in July of ingots and castings amounted to 428,700 tons, or about 200 tons less than the quantity produced in June. Output from the steel works, however, is much lower than it was twelve months ago.

Finished Iron.

Practically all the finished iron works in Staffordshire have now resumed work, but there is insufficient business to provide a full week's work, and few of the mills are active for more than three days a week. There is a shortage of orders in all departments, and the marked bar department which in the past has been more fortunate than the Crown and common bar branches, is now keenly feeling the effects of the continued slump in trade. It is fortunate for Staffordshire makers that their iron has such a splendid reputation. It is still called for for exacting engineering work, and it is confidently believed that as soon as matters begin to mend there will be an increasing use of best grade iron. Prices are maintained at £12 per ton at makers' works. Crown bars range from £9 5s. to £10 5s., while nut and bolt and fencing bars are quoted £8 7s. 6d. There is little business passing in either of the two latter classes of material. Strip mills are underemployed. Orders show a falling off, and it is with some difficulty that values are maintained. The general quotation is upheld at £10 12s. 6d. per ton delivered.

Galvanised Sheets.

Keen competition in the galvanised sheet industry is responsible for a further weakening of prices. Large export orders have this week been accepted at 2s. 6d. per ton below last week's minimum, and there are rumours that this does not fully represent the decline in values. Twenty-four gauge galvanised corrugated sheets have been sold at £9 5s. per ton f.o.b. Liverpool. It is said that £9 2s. 6d. would not be refused in some quarters for large tonnage orders. For small-scale business, such as is provided by the home trade, local mills require £9 10s. to £9 12s. 6d. per ton. Even this figure, they assert, does not provide a reasonable margin of profit. Reports that additional mills are being put into operation in South Wales in consequence of better order books encourage hopes of improved business for makers in this area. Local mills have capacity for a considerably larger output than they are at present making. All the local works have now resumed operations.

Coventry Engineering.

Coventry's main industry—automobile engineering—is but poorly engaged just now, it being the "off season." Allied trades are likewise experiencing a quiet time, and improvement is unlikely until after the Motor Show in October. Activity is maintained at recent satisfactory levels in the electrical engineering trade, and this fact eases the position somewhat. Work on automatic telephones and exchanges for home and overseas provides steady work, while factories engaged in the production of wireless equipment remain busy.

Unemployment.

Unemployment in the Midlands continues severe, and recent returns show that the effects of the Bank Holiday period are still in evidence. The latest total of unemployed in the Midland division is 433,955, an advance of 27,092 on the week before the holidays. The existing total is 116,147 in advance of that recorded in the corresponding week a year ago. Birmingham's total is 74,237; Stoke-on-Trent area, 50,321; Coventry, 17,336; Leicester, 18,900; Nottingham, 18,498; Wolverhampton, 16,863; Walsall, 11,555; Cradley Heath, 10,352; Derby, 10,503. It is anticipated that the next returns will show a marked improvement in the situation.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Textile Machinery for Abroad.

WITH the continued depression in the Lancashire cotton industry and much surplus machinery in existence, the home market prospects for textile machinists for the immediate future are anything but bright. The demand from abroad has also fallen off substantially compared with the last two years, though it is refreshing to note that shipments in July were above the average for the previous months of this year. According to the Board of Trade returns, the total exports of textile machinery in July amounted to 4586 tons, valued at £495,481, compared with 9221 tons and £852,681 a year ago, and 14,109 tons and £1,296,485 in July, 1929. There has been no expansion in the Russian market, whose takings continue to be but a fraction of what they were, and although British India is easily the biggest buyer still the shipments thence are little more than half what they were in either of the two previous years. The exports to India during the month reached a total value of £154,673. France comes a poor second with £36,800, followed by Germany, £33,221, China £28,821, South America £25,167, Japan £22,121, the Netherlands £20,830, the United States £13,674, and Australia £5189. "Other European countries" accounted for £112,193 of the total exports last month. In the aggregate, shipments in the January-July period this year amounted to 30,316 tons, valued at £3,082,691, against

59,403 tons and £5,672,497 in the first seven months of last year, and 79,136 tons and £7,170,932 in 1929.

Preston to Bermuda.

Three petrol-driven railway coach and trailer units, manufactured at the Preston works of the English Electric Company, Ltd., for service in Bermuda, were expected to leave Liverpool this week by the s.s. "Arcadian." Running tests have been carried out on a branch line of the London, Midland and Scottish Railway at Preston. The tests, which were regarded as highly satisfactory, showed that the petrol-driven coaches were economical to run, and the view was expressed that railway vehicles of this type would prove of great advantage to British companies in the operation of suburban line services.

Personal.

Mr. J. B. Storey, of the firm of J. B. Storey and Co., machinery exporters, Faulkner-street, Manchester, has been appointed general manager of the Lancashire Industrial Development Council. Sir Harold Morris, K.C., has been invited to become chairman of the Joint Wages and Hours Board for the Lancashire and Cheshire coal-mining industry. A contentious matter awaiting settlement here is the application of the men engaged on mechanical conveying plant for an increase in wage rates.

Obituary.

Mr. Henry Wood, who had been a director of J. Musgrave and Sons, Ltd., engineers, of the Globe Ironworks, Bolton, and who, until the firm closed down in 1912, was head of Messrs. J. and D. Wood, of the Victoria Foundry, Bolton, has died at Bolton at the age of seventy-one years. The death occurred last Saturday at his home at Eccles, near Manchester, of Mr. James Livesey, metal merchant, of 5, Cross-street, Manchester, at the age of seventy-nine years. Mr. Livesey was one of the oldest members of the Manchester Royal Exchange. He regularly attended the engineering and metal markets, and was present at the meeting on Tuesday of last week.

Non-ferrous Metals.

Apart from an upward movement in the tin section, there has been no improvement in values of non-ferrous metals during the past week, and whilst copper has about held its ground, a further loss has occurred in both spelter and lead. The tendency in the case of tin has certainly been stronger, largely in consequence of Eastern news of a tightening up of output restriction. Prices immediately advanced on the strength of the official announcement, and although the full extent of the improvement has not been maintained, quotations are higher on balance by about £3 a ton. A feature of the tin market has been an increase in buying interest displayed by consumers. On the other hand, copper has been markedly inactive, and the lack of confidence as to the future of prices is reflected in the cautious way in which users are operating, enormous stocks of the metal exercising their usual depressing influence. Values at the moment of writing are only fractionally above those current a week ago, the latter, incidentally, being the lowest in history. Lead and spelter have both further weakened and only a very modest trade has been reported during the past week.

Iron and Steel.

Prospects in the iron and steel trades of Lancashire are not regarded too hopefully, although, until the holidays are out of the way, it is difficult to gauge the exact position. At the moment, new orders for foundry iron are relatively few, although most users have probably already covered their requirements over the next few weeks. Prices are steady at 67s. per ton for Derbyshire, Staffordshire and Cleveland brands of No. 3; 65s. 6d. for Northamptonshire, and about 81s. for West Coast hematite, all for delivery Manchester or equal distance. Little interest is being shown here in Scottish pig iron, sales of which have been adversely influenced by offers of Indian iron at a delivered quotation, which is 14s. to 15s. a ton lower than what is being asked locally for Scottish makes. Apart from a fair-sized order for boiler plates in connection with a Russian contract secured by a Lancashire firm of engineers, there has not been much business passing in the steel section, either in home or foreign products, and inquiries this week have been confined to small parcels for prompt delivery. So far as British steels are concerned, there has been no change in the price situation, but the fresh wave of weakness recently reported in continental products has extended and further concessions have been made in billets and sheet bars.

BARROW-IN-FURNESS.

Hematite.

There is no sign of improvement in the hematite pig iron trade, and though production at the present time is very low, the demand does not equal it. There is some talk of furnaces going out, but nothing definite is known yet. Trade is at present on a hand-to-mouth scale, and buyers are not inclined to order more than is required to meet bare necessities, although it is doubtful if iron will be as cheap again as it is at present. The continental and American demand is very dull indeed. American pig iron requirements are negligible. The local iron ore trade is but a reflection of the iron trade and shows very little activity. Business in foreign ores is also flat. The steel trade has little life in it at present, and recent rumours about certain works restarting seem to have been premature. In hoops and small sections there is a moderate demand, and shipments still continue to a certain extent.

SHEFFIELD.

(From our own Correspondent.)

Stainless Steel Activity.

In the midst of gloomy reports of bad trade it is pleasant to find an expression of satisfaction with the condition of the stainless steel section. Production of this quality of steel is being maintained, despite the widespread depression, and the reason for this may be found in the varied and new uses of the material. Good orders are being received from chemical works, and large quantities are being used for such purposes as turbine blades, motor car parts, road studs and shop fronts. With other special steels Sheffield firms do good business, but this section has declined somewhat recently. The open-hearth departments continue in a state of acute depression, and in the majority of departments it is not expected that there will be any noticeable improvement before next month.

Economy Moves.

Nearly all the steel works in the Sheffield district are being operated on a reduced scale, and complaints are made that the turnover in many cases is not sufficient to do more than cover expenses. Consequently firms are having to pursue a policy of strict economy and salary cuts have been made. Members of the staff of Thos. Firth and John Brown, Ltd., have had to face an all-round cut of 15 per cent. in salaries, from the directors downwards, and similar positions have arisen in other firms recently.

Significant Export Figures.

A slight increase in the export of iron and steel materials is reported in the figures for last month. The increase is small, but satisfactory, inasmuch as it is in the right direction and leads one to hope that the worst of the depression has passed. The figures for the seven months of this year show a decline upon last year's figures from 2,100,984 tons to 1,167,551 tons. The most unsatisfactory feature of the returns is provided by railway material, exports of which continue to shrink, whilst increasing quantities of foreign steel rails have been arriving in this country recently. During July exports of special steels —199 tons—were 32 tons less than in June, 49 tons less than in July last year, and 166 tons less than in July, 1929. Over the seven months the value of this important Sheffield trade has declined from £315,063 last year to £190,065 this year, and in the meantime imports of special steels have increased, the figure for July being 138 tons, as compared with 107 tons during the previous months.

Huge Steel Casting.

A huge steel casting, weighing nearly 70 tons, had to be hauled from the Grimesthorpe Foundry, Sheffield, of the English Steel Corporation by three traction engines. It was removed to the Carlisle-street East Works of Davy Brothers, Ltd., and is one of seven castings being used by Davy Brothers for a 6000-ton forging press which is being manufactured to the order of the Russian Government. The lightest of the castings weighs 22½ tons and the heaviest —the one just mentioned—is 69½ tons. This latter casting comprises the main base-plate girder, its dimensions being 24ft. by 7ft. by 7ft., and its weight is as delivered before machining. In casting this girder it was necessary to use 87 tons of steel, poured from two large ladles.

Modern Plant and Foundry.

The new foundry and spun pipe plant of the Staveley Coal and Iron Company is to be opened officially on September 16th. This will be the first use of the sand spun process in Great Britain, and the latest development of the centrifugal casting of pipes. Visitors on the occasion of the official opening will find much of interest in addition to the new plant, for the company has a great variety of interests apart from coal and iron. There are plants for making aniline, sulphuric acid, oleum, hydrochloric acid, liquid chlorine, bleaching powder, caustic soda, sulphate of ammonia, benzole, and nitro-benzole, tar distillation plant, and modern coke ovens, gas washing plant and pig iron furnaces. Three sets of mammoth tandem gas engines, said to be the largest in the world, which are run on the waste gases from the blast-furnaces, will also attract attention.

Sheffield Salvage Experts.

The Sheffield firm of Cox and Danks has successfully carried out salvage operations in connection with the battleship "Emperor of India," which has been refloated from the Owers Bank, off Bognor Regis, where she had been aground since June 11th, after being used as a target ship for experimental firing. After being towed round from Bognor she was kept afloat for twenty-four hours by continuous pumping and eventually towed into Portsmouth Dockyard. It is stated that the cost of salvage operations was about £800 a day. The Sheffield experts worked from inside the vessel, forcing the water out by compressed air and patching the vessel's hull as they proceeded.

Railway Engineering.

Work is nearing completion in removing a bottle neck on the line of the London, Midland and Scottish Railway near Mirfield Station. Traffic is passing on two sets of lines over a new bridge that has been built across the river Calder. This bridge runs parallel with the old stone bridge, which is still sound. When the work is completed, within the next few weeks, four sets of lines will run through Mirfield Station and over the river. The new bridge, which is 620ft. long, has six spans, three of which are over the river. The work has been in progress for sixteen months, under the supervision of Mr. T. Bennett, M. Inst. C.E., the resident engineer.

New Roads and Bridges.

An important diversion and improvements scheme in the Hampole district near Doncaster has been approved by the West Riding County Council, the estimated cost of the work being £75,000. At present work is proceeding in widening the road from Red House to Hampole, a mile north of Doncaster. The new scheme provides for a diversion of the roadway across country and will entail rock cutting and the construction of a new bridge over the railway. Among schemes which have now obtained the approval of the Minister of Transport are :—Edinburgh trunk road, West Riding County Council, construction of a new bridge over the river Nidd near Walshford Bridge, £34,000; Sheffield-Worksop road, Sheffield City Council, widening half mile of Handsworth-road, £26,000; Bawtry-Tinsley road, West Riding, widening and reconstructing three-quarters of a mile between Whiston Cross Road and Haworth Hall Lodge, £27,000.

NORTH OF ENGLAND.

(From our own Correspondent.)

Another Ironworks Closed.

It can no longer be denied that the outlook for the iron and steel trade is distinctly ominous. Production has been declining for some time past, and stocks at makers' yards are heavy. The closure this week of the Redcar Ironworks, following upon the decision of Dorman, Long and Co., Ltd., to blow out the only blast-furnace in operation, provides another incident in the acute period of depression through which the industry is passing. About 500 men will be thrown out of employment. Consequent upon the closing of these works the whole of the men and boys, numbering about 500, at the firm's Carlin How and Lumpsey ironstone mines have been given fourteen days' notice. During the past twelve months six North Country ironworks have been closed down completely :—The Carlton Ironworks, Jarrow Ironworks, Linthorpe Ironworks, Middlesbrough, Dinsdale Ironworks, and the Redcar Ironworks. In every instance the precipitating cause has been the same—bad trade and accumulation of stocks.

Cleveland Iron Trade.

The Cleveland pig iron market is under holiday influences this week, and little business has been transacted. Most of the works are closed down for the annual holidays. Resumption of market activity is not now expected until early next month, when buying to meet autumn needs will be entered upon. The outlook, however, is not encouraging. Export trade is very difficult to secure, and home requirements have fallen off considerably because of slackness at the foundries and other consuming works. Stocks are increasing and one firm is stated to have an accumulation of over 30,000 tons. Makers decline to reduce prices, contending that ruling market rates leave little or no margin of profit. No. 1 Cleveland foundry iron is 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; and No. 4 forge, 57s.

Hematite Pig Iron.

The limited make of East Coast hematite pig iron is in excess of the demand, and the gradual growth of stocks is causing uneasiness. Quotations are irregular terms of sale being a matter of individual bargaining, but producers are not disposed to acknowledge that values are below the equivalent of ordinary qualities at 61s. No. 1 quality is at a premium of 6d. per ton.

Ironmaking Materials.

Little or no effort is made to transact business in foreign ore. Sellers still name 14s. 6d. as the c.i.f. price of best Rubio ore, but spot lots have been done at less. Blast-furnace coke is in ample supply and quiet demand. Ironmasters can still readily cover their needs on the basis of good average qualities at 15s. delivered.

Manufactured Iron and Steel.

With one exception, all the steel works in the Teesside district are closed down this week. Operations have been continued at the Cargo Fleet steel works on some urgent orders. The constructional steel departments still have a lot of work to execute, but nearly all other branches of manufactured iron and steel production are greatly in need of orders. Quotations are unaltered.

Shipbuilding Order.

W. Gray and Co., West Hartlepool, have secured an order for another 9000-ton steamer from Messrs. Harrison, for whom the firm has built a number of boats in the past. This makes the second order for a 9000-ton vessel secured by Messrs. Gray's within a few weeks. The first was placed by Sir R. Ropner and Co., Ltd., and work in connection with the vessel was started last week. There has been no ship construction work in the Hartlepools for nearly two years, and the orders are extremely welcome at a period of almost unparalleled depression in the industry.

The Coal Trade.

The prospects for the remainder of the month give no promise of increased activity in the Northern coal trade. Operators are apparently awaiting the outcome of the political talks in London as to future financial developments. Until the business world becomes more confident there is little likelihood of any active trade setting in. Conditions at the collieries still continue difficult. A few collieries are working right up to the quota this week. In one or two instances in Northumberland collieries have orders, but cannot execute them, as their quota has already been completed; but generally in both counties—and particularly Durham—stocks are plentiful and orders few, while pits are working irregularly. There is practically no new inquiry for early shipments of steam coal, and collieries are relying on old contracts to absorb the bulk of the current output. Buyers find no difficulty in obtaining the best qualities at 13s. 6d. Prime Wear steams can be readily secured, but fitters hold firmly to a minimum of 15s. for best screened and 12s. for small. Tyne primes are quoted steadily, and the supply on offer is not excessive at 12s. 9d. No animation is to be observed in any class of gas coal, and current output is ample to meet all demands, there being no prospect of increased business for a few weeks ahead. Best kinds are offered at 14s. 6d. and seconds are plentiful at 13s. Durham coking unscreened are being pressed on the market at 13s. 3d. Bunker coals are irregular. Best are in good demand and steady at 13s. 6d. to 13s. 9d., but seconds are weak at 13s. Shipments of coke are keeping up the recent average, but forward

business is scarce, with the undertone easier. Patent oven coke for prompt sale is obtainable at 15s. to 15s. 6d., but forward up to 16s. is asked. Gas coke is quiet, but steady at 18s.

SCOTLAND.

(From our own Correspondent.)

Markets Inactive.

It has been usual at this season of the year to find evidence of an expansion in business. At present, however, in steel, iron and coal, signs of improvement are entirely lacking. World depression has shouldered the blame for some time for the shortage of orders in steel and iron, and keen foreign competition for the lack of foreign business in coal, and now the financial situation is quoted as the most detrimental feature. Whatever the cause, there is no gainsaying the fact that markets generally continue in a most listless state and almost wholly without encouragement.

Steel.

Steel makers experience the greatest difficulty in keeping plants in operation. Works are no better off for orders than they were before the summer holidays. Recent orders for shipbuilding will help matters in Port Glasgow and Dumbarton, but the majority of the shipyards are not likely to be able to offer specifications for material for some time to come, unless a rapid change in the situation takes place. Though, as yet, there is no sign of a seasonal demand from India and Canada, it has been said that makers here are quite confident that business cannot be long delayed. Black sheets are tolerably well placed, but galvanised descriptions have developed further weakness. Galvanised corrugated sheets 24 gauge are quoted £11 7s. 6d. home and £9 15s. for export, though it is said that a figure as low as £9 2s. 6d. f.o.b. has been done. The tube trade is very quiet. Several orders for propelling machinery have just been placed in connection with tonnage now being built, or to be built, on the Clyde, but with so many berths unoccupied these orders can only touch the fringe of the existing depression.

Iron.

Bar iron and re-rolled steel bars move slowly. The home price of the former is fixed, but the export quotation of £9 15s. might be shaded for an acceptable order. The tendency in re-rolled steel bars is easier, though the home and export price is nominally unchanged at £6 per ton. The pig iron furnaces damped down before the annual holidays have not yet been restarted and only one remains in operation. Business is very dull and considerable quantities of material continue to arrive in this district from India, the Continent, and across the border. Shipments of pig iron from the Clyde last week only amounted to 70 tons (20 tons foreign), compared with 321 tons (21 tons coastwise) in the same week last year.

Scrap.

The demand for scrap still languishes and prices continue easy at about 49s. 3d. for cast iron machinery, and 37s. 6d. per ton heavy steel.

Coal.

In all districts of Scotland the collieries suffer from a general lack of business. Home demands are affected by the industrial depression, while shippers continue to experience great difficulty in securing orders abroad in competition with Polish fuel. Despite a considerable reduction in outputs and interference with work at the collieries in all districts owing to a strike of surfacemen, supplies of fuel are ample and prices weak. The only exception is provided by double nuts, which are in short supply and firm. Aggregate shipments amounted to 187,763 tons, against 169,957 tons in the preceding week, and 237,519 tons in the same week last year.

Surfacemen's Strike.

For over a week certain collieries in all Scottish districts have been affected by an unofficial strike of surfacemen. At one time it was thought that the trouble might spread, but, at the moment, it appears as though the strike has been broken, as work has been wholly, or partially, resumed at several of the collieries affected.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

As expected, the returns of coal and coke shipments from the six ports under the control of the Great Western Railway Company in this Channel showed a substantial improvement last week. The tonnage position at the beginning of the week was sufficiently good to give grounds for optimism regarding the results, though it must be admitted that such good work was done at the docks that by the end of the week the situation from the tonnage point of view was far from satisfactory, and there were no less than thirty-six idle tipping appliances, as compared with thirteen at the beginning of the week. Nevertheless, the total shipments for the week came to 466,100 tons, which was 206,970 tons more than for the previous week, when operations were so adversely affected by the holidays. As compared with the corresponding period of last year, there was a decrease of 32,900 tons, which, considering the general state of trade prevailing for so many months past, cannot be regarded as at all bad. Unfortunately, the prospects of last week's total being maintained are somewhat remote. The position this week has not so far been good. Bad weather probably accounted for arrivals over last week-end being below the average, and on Monday the number of idle tipping appliances at the principal ports was as high as thirty-eight. Tonnage should come along better very shortly, as chartering last week showed an expansion; but it cannot be said that the general demand from abroad for coals for early shipment shows any improvement. The inquiry from Spain is particularly quiet, and the conditions in other directions are extremely inactive. Business for South America is unusually difficult, the competition from German producers being so intense that exporters of coals from this district can scarcely look at the prices which are being accepted. There has, of course, been speculation as to how South Wales will be affected by the year's moratorium on the payment of reparations and inter-Allied war debts. Some uneasiness was felt by the report in a London contemporary last week that, following an interview between the German and Italian Ministers, it had been decided that, in the event of reparations being ended or modified, Italy would continue to buy from Germany the coal she at present receives by way of reparations in kind and also that "the annual 2 million tons of coal purchased by Italy from Great Britain will, consistent with special quality needs, be supplied from the German mines." The accuracy of this report is, however, seriously questioned, and it should be pointed out that the reference to "2 million tons" is wrong, as the quantity of coal from this country which the Italian Government undertook to buy under the Hague agreement on behalf of the Italian State Railways was 1 million tons per annum. If, however, as the result of the suspension of reparation deliveries of coal from Germany, or even a partial suspension, the Italian market becomes open to competition, the belief prevails that it will be to the advantage of South Wales, as, on an economic basis, coals can be shipped on a cheaper scale from this district than they can from Germany.

Coals for France.

Returns of shipments of coal to France showed that there was quite a spurt last week, and it is evident that everything is being done to ship as much as possible to that country this month, as it is well known that from the beginning of September the application of the French licensing system is to be carried out more rigorously. No fresh news has so far come to hand on this subject, except that representatives of the Polish mining industry have been in Paris lately and have proposed that there should be a modification in the system under which licences are to be granted by the French authorities for the importation of foreign coals into France. It is stated that the Polish representatives are demanding an increase in their quota, so that the quantity shall approximate to their current volume of exports and that the Polish Government supports their demand and even threatens commercial reprisals unless substantial concessions are made. There can be no question that the position requires the utmost watchfulness, as if any concessions are made the belief prevails that it may be at the expense of the British coal export trade.

Coke-oven and By-product Plant Workers.

The award of the arbitrator appointed by the Minister of Labour under the Industrial Courts Act, to determine the percentage payable on the standard base rates of coke-oven and other by-product plant workers employed in the South Wales coalfield was received by the interested parties last week. The employers claimed that existing percentages should be reduced by 20 points. The workmen opposed this claim and contended that there should be no alteration. The percentages, which differ in the case of various workmen, are, at the present time, 30 per cent. at one works, 32½ per cent. at five works, 35 per cent. at one works, and 40 per cent. at another works. The arbitrator has reduced the percentages in three cases by 6½ points and in the fourth case by 7 points.

Rumoured Amalgamations.

During the past week rumours have been current regarding big amalgamations of coal interests in this district, but these reports have no foundation from the information to hand. The name of Gueret, Llewellyn and Merrett, Ltd., has been principally mentioned in this connection. An authoritative statement which has been issued shows that this important undertaking and the Welsh Associated Collieries, Ltd., have developed and made closer still the alliance which has existed for several years with one of the largest and most powerful French and North African importing houses with important branches in various parts of the world. Certain agencies of the French house will be transferred, though each company will continue to retain its separate and independent entity.

Docks Traffic.

Returns issued by the Great Western Railway Company of the traffic at the six docks in this district under its control for the four weeks ended August 2nd, give a total of imports and exports of 2,090,480 tons, made up of 299,397 tons imports and 1,791,083 tons exports. These figures compare with an aggregate of 2,401,538 tons for the preceding month, made up of imports 330,424 tons and exports 2,071,114 tons. For the whole of this year to August 2nd imports came to 2,323,595 tons and exports 14,052,058 tons, making an aggregate of 16,375,653 tons, which compares with an aggregate of 21,664,785 tons for the corresponding period of last year, this being made up of imports 3,013,703 tons and exports 18,651,082 tons.

Coalfield and Other Items.

All the officials and workmen at the Bedwas Navigation Colliery received at the end of last week notices to terminate their contracts in fourteen days. No explanation of this action has been forthcoming, but the matter was referred to at a meeting of the executive council of the South Wales Miners' Federation on Monday by representatives of that council, who had been negotiating with the owners with respect to the re-employment of workmen. The council authorised the representatives to continue their efforts to obtain a continuance of work at the colliery. The position at the Tirpentwys Colliery has improved slightly. It had been intended to close down the No. 2, or smaller, pit. Of the 480 men whose notices expired on Friday last, over 100 are for the present to be kept employed on day-to-day contracts. Owing to the depression which continues in the patent fuel industry, the Rose Fuel Works at King's Dock, Swansea, closed down on Saturday until trade improves. About 300 men are affected. The Crown patent fuel works at Cardiff, belonging to British Briquettes, Ltd., established a record last week, as 15,873 tons were actually shipped. The s.s. "Segura" loaded 6500 tons in 47 hours, and when it is realised that this shipment consisted of 574,999 separate blocks, all of which had to be man-handled, it will be appreciated how good the performance was. Compared with six months ago, the number of tippers employed at the Barry Docks by the Great Western Railway Company is now only about one-third. A few more tippers at Barry received notices last Saturday. The number now employed is in the region of 200, which is the lowest for many years past.

Furnace "Break-out."

A serious "break-out" at No. 4 furnace at the Dowlais Works, Cardiff, belonging to the British (Guest, Keen, Baldwins) Iron and Steel Company, Ltd., occurred on Tuesday afternoon, and caused very considerable damage. This is the furnace which was erected barely two years ago, and with which the record output for Great Britain was secured in May last. Fortunately, rumblings in the furnace served as a warning signal, and all the workmen were hurried from the zone of danger, with the result that no lives were lost and no one was harmed. The break-out was terrific, a sheet of flame and smoke shooting up 200ft., to the alarm of all the residents in the neighbourhood, and visible to people on the opposite side of the Bristol Channel.

Current Business.

The tone of the steam coal market continues to be generally quiet, and there is very little fresh inquiry coming along for either prompt or forward delivery. The position of individual collieries varies considerably, but there is no doubt that quite a large number are losing a good deal of time owing to the slackness of the demand. Small coals especially are plentiful and difficulty is experienced in finding an outlet for them, while large qualities are irregular. Coke shows no change and there is no material alteration so far as the demand for patent fuel is concerned. Pitwood is not coming along so freely and the tone of the market, notwithstanding the limited inquiry, is steadier.

LAUNCHES AND TRIAL TRIPS.

A steam ferry, built by the Netherland Shipbuilding Company, to the order of the Dutch Government; dimensions, 34 m. by 13·50 m. by 4·30 m. Constructed by N. V. Verschure and Co.; launch, August 1st.

CONTRACTS.

The Nob-Rust Liquid Lead Company, Ltd., has received from the Great Western Railway a contract for the coating of approximately 200,000ft. of steel with "Nust" at the docks at Fowey.

J. W. Jackman and Co., Ltd., Blackfriars-road, Manchester, have received an order from the Suffolk Iron Foundry (1920), Ltd., of Stowmarket, for sand distribution and mould conveying equipment, including elevator and conveyors.

CATALOGUES.

British Steel Piling Company, Ltd., 54A, Parliament-street, S.W. 1.—Leaflets on "Spiro's" air compressors.

Dunlop Rubber Company, Ltd., St. James' House, St. James'-street, S.W. 1.—Publication on anti-corrosion rubber.

British Thomson-Houston Company, Ltd., Rugby.—A booklet on fractional H.P. electrical motors for both A.C. and D.C. circuits.

General Electric Company, Ltd., Magnet House, Kingsway, W.C. 2.—Pamphlet H O 5884 of electric furnaces and ovens as applied to industry.

Robert Dempster and Sons, Ltd., Elland, Yorks.—A brochure illustrating some examples of modern power station coal-handling plants installed by the firm.

W. F. Stanley and Co., Ltd., 286, High Holborn, W.C. 1.—A 450-page catalogue dealing in detail with the firm's products, which include theodolites, levels, sextants, microscopes, calculators, and drawing-office and surveying instruments of all kinds.

Bakelite Engraving Sheets.—The uses to which bakelite may be put are numerous and continue to increase. The most recent field of employment has been rendered possible by the development of a process whereby it is possible to produce sheets of laminated bakelite, the laminations being sharply defined and in contrasting colours. Two samples of this material have been sent to us by Bakelite Ltd., 68, Victoria-street, S.W. 1. One consists of a sheet of black bakelite with a thin layer of white bakelite on one face. The other consists of two black laminations, between which there is interposed a white layer. The sheets have an obvious use in the production of engraved name plates. By means of an ordinary engraving machine the top layer is cut away, leaving the letters in the colour of the lower or intermediate layer. In the case of the samples mentioned, for instance, the result of the engraving would be a white name plate with black lettering or, in the second instance, a black name plate with white lettering. In addition to the ease with which the material can be engraved and its stout resistance to many destructive agencies, the laminated sheets have the advantage of giving a name plate which is easily read without the use of any filling for the letters.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/– to 20/6
(1) Spanish	14/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	14/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 10 0	—
No. 1 Foundry	3 13 6	—
No. 3 Foundry	3 11 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 1 0	3 1 0
No. 1	3 1 6	3 1 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*); 4 0 6 (*b*); 4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 10 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
Lancs.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6 to 9 0 0	—
Gas Tube Strip	10 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 10 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 10 0	7 10 0
Sheets (Gal. Cor. 24 B.G.)	11 7 6	9 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 10 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 0 0	—
Sheffield—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 15 0	—
Midlands—		
Small Rolled Bars	6 7 6 to 7 0 0	—
Billets and Sheet Bars	5 0 0 to 5 15 0	—
Galv. Sheets, f.o.b. L'pool	9 5 0 to 9 12 6	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 0 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 t.o.b.	13/3 to 13/6
Block Tin (cash)	114 7 6
„ (three months)	116 15 0
Copper (cash)	32 8 9
„ (three months)	33 6 3
Spanish Lead (cash)	11 10 0
„ „ (three months)	11 12 6
Spelter (cash)	11 0 0
„ (three months)	11 12 6
Manchester—	
Copper, Best Selected Ingots	36 0 0
„ Electrolytic	37 0 0
„ Strong Sheets	66 0 0
„ Tubes (Basis Price), lb.	0 0 10½
Brass Tubes (Basis Price), lb.	0 0 9½
„ Condenser, lb.	0 0 11½
Lead, English	13 2 6
„ Foreign	11 15 0
Spelter	12 0 0
Aluminium (per ton—raw ingot)	£85

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11½ per lb.	
Ferro Tungsten	1/8½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£20 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£19 17 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£30 0 0	10/–
„ „ „ 1 p.c. carbon	£34 0 0	12/–
„ „ „ 0·70 p.c. carbon	£35 10 0	14/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£10 10 0 scale 5/– per unit	
„ „ 75 p.c.	£15 0 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170	
Ferro Cobalt	8/9 per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/6
„ „ Ell	14/3
„ „ Splint	14/– to 15/9
„ „ Trebles	12/– to 12/6
„ „ Doubles	11/– to 11/6
„ „ Singles	10/– to 10/3
Ayrshire—	
(f.o.b. Ports)—Steam	13/6
„ „ Jewel	17/–
„ „ Trebles	12/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	10/6 to 12/3
Screened Navigation	16/6 to 17/6
Trebles	12/– to 13/6
Doubles	11/9 to 12/–
Singles	10/6
Lothians—	
(f.o.b. Leith)—Best Steam	10/9 to 11/–
Secondary Steam	10/6
Trebles	11/6 to 12/–
Doubles	11/9
Singles	10/–

ENGLAND.

(8) N.W. Coast—	
Steams	20/–
Household	30/– to 51/–
Coke	20/– to 20/6
Northumberland—	
Best Steams	13/6
Second Steams	12/–
Steam Smalls	7/6 to 8/–
Unscreened	12/6 to 13/–
Household	27/– to 39/–
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–
Sheffield—	Inland.
Best Hand-picked Branch	24/6 to 25/6 —
Derbyshire Best Bright House	19/– to 20/– —
Best House Coal	18/6 to 20/– —
Screened House Coal	17/– to 18/– —
„ „ Nuts	14/6 to 15/– —
Yorkshire Hards	15/– to 16/6 —
Derbyshire Hards	15/– to 16/6 —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	6/– to 7/6 —
Smalls	4/– to 5/6 —
Blast-furnace Coke (Inland)	12/3 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 13/– to 14/–	

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 19/3
Ordinary Dry Large	17/9 to 18/–
Best Black Vein Large	18/3 to 18/9
Western Valley Large	18/– to 18/6
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/9 to 18/–
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	18/– to 21/–
No. 3 Rhondda Large	19/9 to 20/–
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/– to 36/6
Furnace Coke (Export)	16/6 to 17/6
Patent Fuel	19/9 to 20/–
Pitwood (ex ship)	22/6 to 23/–
Swansea—	
Anthracite Coals:	
Best Big Vein Large	35/– to 37/6
Seconds	27/– to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 45/–
Nuts	40/– to 46/–
Beans	24/9 to 28/3
Peas	21/– to 22/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/6 to 9/–
Steam Coals:	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 22/6 Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Engineering Trades.

THOSE branches of the engineering industry that are still employed upon the execution of old contracts are threatened with a serious shortage of work unless something is done to finance the various sources of industrial activity, notably the carrying out of railway undertakings. The railway companies are holding off the market not only for reasons of economy, but also, it is said, because they contemplate a reorganisation of the transport service by lengthening the runs of local trains and dealing with intermediate traffic by motor vehicles. Until the companies are assured that the Government's proposals for financial relief will be adopted and they have established a definite plan of working for the future, it is not likely that much new business will be given out to locomotive and wagon builders. For the moment, orders are few, amongst them being one for an oil-electric shunting engine, which is the first of its type to be supplied to a French railway company. The colonial administrations intend to equip the trains with continuous brakes and automatic couplings, so that hopes are entertained of the colonies providing work in the early future. Until recently, makers of electrical machinery have been fully employed, but even they find that the outlook is becoming very uncertain.

Shipbuilding.

Notwithstanding the higher costs at French shipyards as compared with those in some other countries, special efforts are being made to secure foreign orders, and it is affirmed that French builders submitted the lowest tenders to Portugal for submarines, which were, nevertheless, ordered from Italy, in addition to contracts for other ships secured by British firms. In the same way, French shipbuilders failed to obtain orders that they were expecting from Greece. There is no doubt that builders are prepared to make sacrifices with a view to securing foreign business, though so far without success. Being almost destitute of new work, they are exploring every avenue of business, and believe that the construction of steel canal barges to replace the 12,000 wooden boats in service will provide them with some activity, especially as the boats are necessarily of standardised construction. The old boats are being superseded by steel barges, which are mostly supplied by Holland, and it is now intended to raise the import duties on steel hulls so as to ensure a monopoly of the business to home shipbuilders.

A New Liner.

The liner "Champlain," of 28,627 tons displacement, which was launched at Saint-Nazaire last Saturday, is regarded as a type of boat that must necessarily survive the competition for traffic, and now that shipowners have come to an international agreement for a reduction of passenger freights, it is hoped that they will, at some time, accept a limitation of displacement, though there seems little chance of that being done without State intervention. The construction of the 70,000-ton liner is now found to be a very arduous enterprise at a time when the Compagnie Générale Transatlantique is in difficulties, and it is, moreover, certain that this ship, which is built for national prestige, can never pay its way, wherefore it is suggested that it would be prudent for shipowners in France, Great Britain, Germany and the United States to restrict competitive building to ships that can be run at a profit. The "Champlain" has a length of 195·5 m. and a width of 25·25 m. She will have six oil-fired steam generators and two groups of turbines, each of 24,000 horse-power.

Coal Restrictions.

The operation of the coal import licences has given satisfaction to coalowners, but it is seriously harming other interests, and particularly those ports that depend for much of their activity on the coal trade. That was foreseen by the Association des Grands Ports Français, which issued a strong protest against anything being done for the protection of the colliery industry that would deprive dockers of employment, when the object of the licence system was avowedly to prevent the discharge of miners who were, for the most part, foreigners. Since the licence system came into operation the port of La Rochelle, for example, has experienced so heavy a decline of traffic that for days together there have been no ships in the harbour. The Chamber of Commerce of that port has, therefore, sent a protest to the Government which it charges with having failed in its promise to do nothing detrimental to the interests of the ports, and it insists again upon the unreasonableness of sacrificing the ports to the interests of coalowners who, it is affirmed, could dispose of their stocks by lowering prices. That, of course, is the cause of the whole trouble, since coalowners could not lower prices without reducing wages.

Electrically Welded Destroyer.

The destroyer "Epervier," which was launched at Lorient last week, is of the "Gerfaut" class, with a displacement of 2480 tons, and it is the first of the lighter craft in which electric welding of the hull and high-resistance metals have been employed, while another experiment is the use of superheated steam. The engines will develop 75,000 horse-power and the destroyer is expected to steam at 36 knots.

Telephone Tunnels.

The telephone cables in Paris are now practically all laid in special tunnels, the latest section from the Place Daumesnil to the Avenue des Ternes, a distance of 8½ miles, having been opened recently. The tunnel is 1·5 m. wide and 2·1 m. high, and it is laid at a depth varying from 6 m. to 10 m. The total length of the tunnels is 25 miles.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

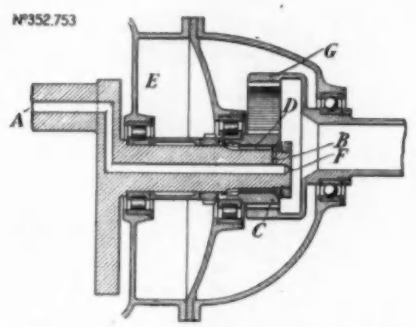
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

352,753. July 28th, 1930.—LUBRICATION OF CRANK SHAFTS AND GEARING, Wolseley Motors (1927), Ltd., and C. O. Towler, Drew's-lane, Ward End, Birmingham.

This invention is concerned with the lubrication of the gear of radial type, geared, aero-engines. The lubrication is effected through the length of the crank shaft, and the aim is to avoid weakening the shaft by transverse drilling where it is subject to torsional stresses. The oil is supplied through the passage

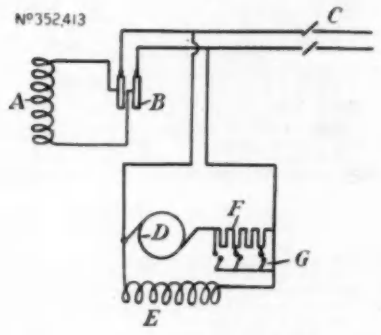


A and escapes through the radial hole B, which is nearly at the end of the driving shaft at its point of connection with the driving pinion C. The oil passes back by the passages D to provide splash-lubrication in the valve gear chamber E, and squirts out through the orifice F to lubricate the gear G.—*July 16th*, 1931.

DYNAMOS AND MOTORS.

352,413. April 7th, 1930.—CONTROL OF SYNCHRONOUS DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2; and Dennis Ernest Jewitt, of "Sunny Bank," Old Bilton, Rugby.

This invention is particularly, although not exclusively, applicable to electric ship propulsion equipment where considerations of space must receive close attention. A represents the field of a slow-speed synchronous motor which is to be periodically connected to and disconnected from a source of supply and to have its direction of rotation reversed. B represent the slip rings of the synchronous motor, and C a control switch, which may be operated manually or automatically from a remote point, and which effects the connection of the synchronous motor to the source of supply. Connected permanently in shunt with the field winding A is an auxiliary D.C. motor having an armature D, field winding E, and series resistance F of such value that with the D.C. motor it constitutes an impedance of suitable value to serve as the starting resistance for the syn-

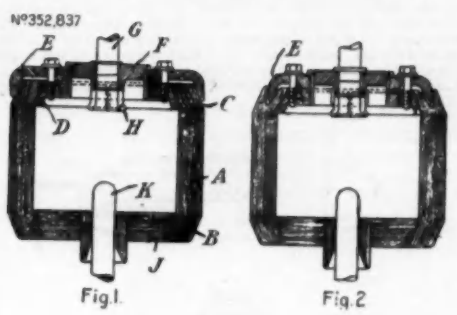


chronous motor when the supply to the latter is completed through the switch C. The resistance F is adapted to be short circuited and re-inserted in steps by a contactor, illustrated diagrammatically at G when the supply to the synchronous motor is completed or interrupted respectively, the contactor G being preferably automatic in its action and dependent upon the operation of switch C. An important point about the auxiliary motor starting resistance F is that the total value of this resistance is proportioned so as to limit the circulating current through the synchronous motor field winding A to the required value during the reversing and starting up periods. This circulating current is the result of the synchronous motor operating as an induction machine and at the commencement of the reversing period has a frequency approaching double the frequency of the A.C. power supply. During the starting and reversing periods of the synchronous motor an A.C. of varying frequency circulates in the synchronous motor field system and the auxiliary motor starting resistance which is in this circuit during this period is proportioned to keep this current to a value suitable for the best results during this particular period.—*July 7th*, 1931.

SWITCHGEAR.

352,837. October 7th, 1930.—EXPLOSION POTS FOR OIL SWITCHES, *International General Electric Company, Inc.*, 120, *Broadway, New York, U.S.A.*

The object of this invention is to reduce the space required by explosion pots. A indicates a cylindrical extinguishing chamber of hard paper, the edges of which B and C are conically tapered inwardly. At the upper end C, intended for supporting the chamber, an inner holder D, correspondingly formed, is arranged, and is screwed to the outer holder E in such a manner that the end C of the extinguishing chamber is firmly clamped between both holders. The outer holder in this case presses against the outer surface of the part C. By means of the intermediate piece F the outer holder E is suspended on the leading-through bolt G, to which the flared contacts H are secured. The lower end of the extinguishing chamber is formed by a plate J with an opening which allows a passage for the contact pin K. In Fig. 2 the outer holder does not extend over the upper part of the extinguishing chamber, but fits in like a wedge. In this manner the discharge of the extinguishing chamber is further

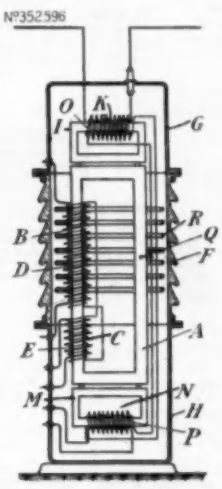


decreased, so that the individual poles of the switch can be brought nearer to each other. A part of the outer holder is simultaneously covered by insulation, whereby the electric strength of the arrangement is increased. In both forms illustrated the inner holder D may be composed of a number of sections individually assembled and screwed into position to form a compact cone.—*July 16th*, 1931.

TRANSFORMERS AND CONVERTERS.

352,596. April 29th, 1930.—HIGH-TENSION TRANSFORMERS, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

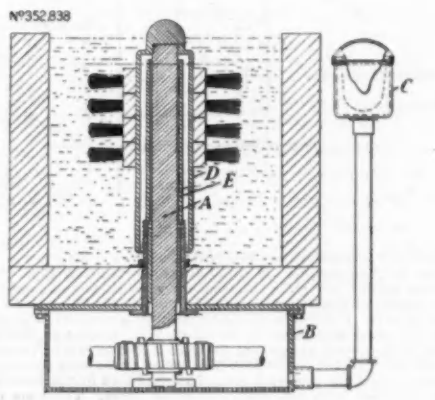
This invention relates to a high-tension transformer, having oil or compound insulation, and having that part of the shell of the casing which extends over the length of the high-tension winding, consisting of insulating material. The potential distribution along the insulating shell is controlled by potential distribution rings, in such a manner that more particularly at the part lying opposite the iron core, the potential drop will be as uniform as possible. The combination of such a voltage transformer with a high-tension current transformer entails the disadvantage that a considerable amount of space is required, owing to the oil vessel with special bushing insulators required for the current transformer. This disadvantage is overcome, according to the invention. A is the iron core of the voltage transformer with the high-tension winding B and the low-tension winding C, which lie next to one another on one limb of the core. D and E are compensating windings for reducing the leakage between the windings B and C. The casing of the voltage transformer consists as regards the part extending along the high tension winding of an insulating cylinder F, with the metal cap extensions G H which act as the high-tension poles. Near the upper yoke part of the voltage transformer core A the core I of one member of the cascade current transformer with the primary winding K is situated, while near the other yoke part of the voltage transformer is the core M of the other member with the secondary winding N, both the cores being electrically connected to the core A. The intermediate windings O P of the two members of the cascade current transformer are connected together and to the core A by the connection shown at Q. The potential distribution rings R are connected to corresponding points of the high-tension winding. The middle of the high-tension winding is connected through one of the potential distribution rings to the iron core of the voltage transformer. With this arrangement there is not only a saving in bushing insulators, but a considerable saving in space is effected, owing to the absence of a separate casing for the current transformer.—*July 16th*, 1931.



TRANSMISSION OF POWER.

352,838. October 8th, 1930.—BEARINGS FOR SUBMERGED SHAFTS, F. Staines, 94, Victoria-street, Westminster.

The more or less obvious intention of this invention is to prevent the contamination of the lubricant in the driving gear of a stirrer by the liquid in a vat above, through the bottom of

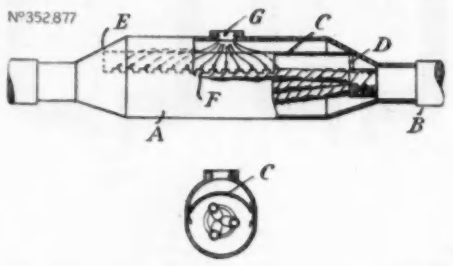


which the stirring spindle protrudes. The stirring spindle is shown at A, while the gear-box is marked B. The gear-box is kept under a slight pressure of lubricant by the reservoir C.

Over the driving spindle there is mounted what might be described as a "diving bell" D, which prevents the liquid in the tank from rising to such a height that it will overtop the sleeve E, and thus gain access to the bearing below.—*July 16th*, 1931.

352,877. November 28th, 1930.—Electrical Cables, *International General Electric Company, Incorporated, of* 120, *Broadway, New York, U.S.A.*

This invention relates to improvements in electric cable joints wherein the joint proper is enclosed by a sleeve which provides a chamber for the reception of an insulating filling mass. The sleeve A is mounted in the usual manner on the cable B at the junction of the cable cores. A partition wall C in the upper portion of the sleeve shell is soldered to the sleeve at the points D and E. Along the side edges of the separating wall openings

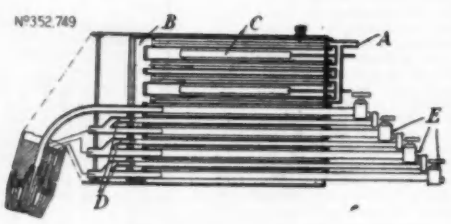


or notches F are stamped out, so that they lie at the points of juncture of the partition wall with the sleeve. For the escape of air from the sleeve, apertures are provided in the partition wall situated as far as possible towards both ends of the sleeve. The filling mass poured in through the opening G spreads over the partition wall of the sleeve in the direction of the arrows, and it forces its way through the lateral openings F into the sleeve and flows down the walls and collects at first in the lower part of the sleeve. As the mass rises in the sleeve around the cable cores any air contained in the sleeve is expelled through the apertures and escapes *vid* the filling hole G.—*July 16th*, 1931.

MACHINE TOOLS AND SHOP APPLIANCES.

352,749. July 23rd, 1930.—Blow-pipes for Cutting Under-water, H. Töpper, 34, Friedrich-Krause-Ufer, Berlin, N. 67, Germany.

This blow-pipe is intended for the sub-aqueous cutting of metal, and is characterised by the fact that it has three concentric heating nozzles, which are supplied with gasified oil, besides the central jet of oxygen for the actual cutting. The oil fuel is supplied by the pipe A and is gasified in the chamber B

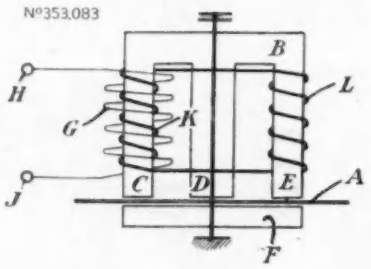


by the electric heaters C. The gas passes by means of branches D D D to the several nozzles by way of pipes, which are indicated diagrammatically. Oxygen is also supplied to these nozzles through the connections E E E, and is preheated in its passage through the chamber B. Each of these supplies is under control, by means of cocks, as is also the main supply of cutting oxygen by the uppermost cock.—*July 16th*, 1931.

MEASURING AND TESTING INSTRUMENTS.

353,083. April 23rd, 1930.—A.C. Electrical Torque Devices, such as Measuring or Recording Instruments or Relays, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2, and Frank Barrell, of the General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

This invention relates to A.C. electrical torque devices, and may be applied, for instance, to measuring or recording instruments or relays. The relay comprises the usual disc A, secured to a shaft, the disc being adapted to rotate against a biassing force, such as that of a spring. The operating element for producing a torque on the disc A differs from the usual form and comprises an E-shaped laminated magnetic core B, having three limbs C, D, and E, the faces of which are arranged adjacent to the top of the disc A, and near the periphery. A laminated magnetic member is provided at F. A winding G connected to terminals H and J is arranged on the limb C, together with a

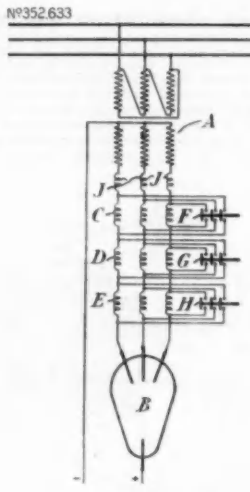


winding K connected in series with a winding L arranged on the limb E. The terminals H and J are connected to a single-phase power supply, thereby energising the winding G and producing a flux in the circuit comprising the limb C, the member F, and the limb D. The flux in the limb C induces a current in the winding K, which also flows in the winding L, thereby producing a flux in the circuit comprising the limb E, the member F, and the limb D. The flux in the limb E is out of phase with that in the limb C, and the vectorial sum of these fluxes in the limb D is out of phase with both the component fluxes. There are thus three fluxes in the limbs C, D, and E respectively displaced in phase relatively to one another, which produce a rotating magnetic field. This rotating field produces a torque on the disc A, which is much more even than that produced by the usual type of operating element.—*July 23rd*, 1931.

MISCELLANEOUS.

352,633. May 15th, 1930.—Means for Operating Eddy Current Rail Brakes, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany, and Gesellschaft m.b.H. für Oberbauforschung, of Europahaus, Stresemannstrasse, Berlin, S.W. 11.

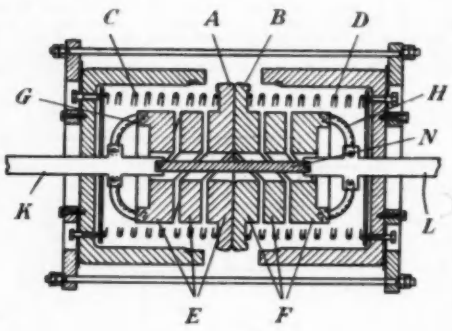
The method of operating eddy rail brakes in accordance with this invention consists in regulating the potential of a direct current fed through a multiphase metal vapour rectifier. A indicates the main transformer, between the secondary winding of which and the rectifier B chokers C, D, and E are connected, and switches F, G, and H serve to switch in the chokes. If, for example, the switch H is closed and the switches F and



G are open, then the current is choked by the coils C and D. When switching in circuits having a large inductance, a further choking coil J may be provided, which automatically chokes down the increased switching potential to the desired continuous potential. This permanent choking coil is thus able automatically to choke down the increased potential which occurs when switching-in under no load to the desired continuous potential. The invention is particularly adapted for operating an eddy current rail brake having a large self-induction and working with an exciting current of over 100 ampères.—*July 16th*, 1931.

353,228. July 8th, 1930.—Methods of and Means for Limiting Short-circuit Currents, Aktiengesellschaft Brown, Boverie et Cie., of Baden, Switzerland.

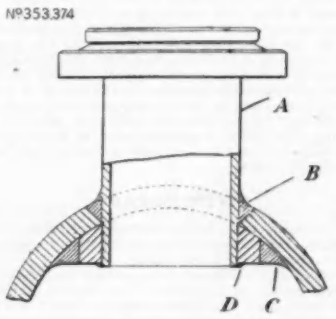
This invention relates to a method and means for limiting the magnitude of short-circuit currents. A and B are contacts pressed together by springs C D. The turns E and F are connected by the flexible cables G and H to the ends of the conductor bars K L. The turns E F are oppositely wound, so that the electric current flowing through them tends to separate the



contacts A B. Parallel to the contacts is the short-circuit limiting resistance N, which is also connected to the ends of the two bars K L. Normally, the current flows from K over G, E, A, B, F, H, and to a small extent over N to L, or in the reverse direction. Should a short-circuit occur, the contacts A B are pulled apart, thus overcoming the force of the springs C D, and the current flows exclusively over the iron bar N, the resistance of which prevents the forming of an inadmissibly heavy short-circuit current.—*July 23rd*, 1931.

353,374. January 16th, 1931.—Branch Connections for Pipes, Aiton and Co., Ltd., and J. A. Aiton, Derby.

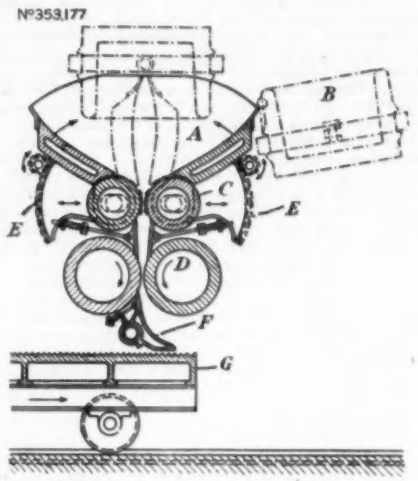
The inventor suggests that existing methods of fixing branches to steam vessels are not satisfactory in view of the high pressures which are now common. As a consequence, he fixes the



branch A by means of an internal nut D, which is shaped to conform to the internal diameter of the pipe or vessel, and makes the joint tight by means of welds at B and C.—*July 23rd*, 1931.

353,177. June 10th, 1930.—Rolling Plate Glass, E. Hilgers, No. 1, Schorlemerstrasse, Düsseldorf-Oberkassel, Germany.

The broad principle of this invention is that as molten glass is drawn from the hopper A, which is supplied by the ladle B, by the rollers C for finishing by the rollers D, the head of glass in the hopper may fall, and, consequently, its rate of feed to the rolls decrease, with the result of an unsatis-



factory sheet. The inventor, consequently, makes the sides of the hoppers pivotal about the axes of the rollers C and brings them together by the gear E E during the process of rolling. The provision of a joint between the sides of the hopper and the ends is suggested, but not explained. The formed sheet of glass is, of course, delivered by the shoe F and is carried away on the table G.—*July 23rd*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

THURSDAY to SATURDAY, SEPTEMBER 3rd to 12th.

"Model Engineer" Exhibition.—Royal Horticultural Hall, Westminster, S.W. 1. Daily.

SUNDAY to SATURDAY, SEPTEMBER 6th to 12th.

International Association for Testing Materials.—Congress at Zürich.

THURSDAY to SATURDAY, SEPTEMBER 10th to 26th.

Shipping, Engineering and Machinery Exhibition.—Olympia, W. Daily, 11 a.m. to 9 p.m.

SATURDAY to WEDNESDAY, SEPTEMBER 12th to 16th.

International Foundry Congress.—Milan.

SATURDAY to SUNDAY, SEPTEMBER 12th to 27th.

International Foundry Exhibition.—Milan.

SUNDAY to FRIDAY, SEPTEMBER 13th to 18th.

Institute of Metals.—Autumn meeting at Zürich. For programme see page 21.

FRIDAY to SUNDAY, SEPTEMBER 18th to 20th.

National Smoke Abatement Society.—Annual Conference at Liverpool.

FRIDAY to MONDAY, SEPTEMBER 18th to 21st.

Association of Special Libraries and Information Bureaux.—At Lady Margaret Hall, Oxford. Eighth annual conference. Friday evening, presidential address, by Professor A. M. Carr Saunders.

WEDNESDAY to FRIDAY, SEPTEMBER 23rd to 25th.

Institution of Mining Engineers.—Manchester. Postponed summer general meeting.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

We are asked to state that the high-pressure air compressors and the compressed air locomotives for the Great Apennine Tunnel mentioned in the article which we published in our issue of June 19th were supplied by A. Borsig G.m.b.H., of Berlin.

On July 6th, the Kernot Memorial Medal for the year 1929, in the gift of the University of Melbourne, was presented to Mr. Joseph Newell Reeson, M. Inst. C.E., M. Inst. Gas E. Mr. Reeson was engineer-in-chief to the Metropolitan Gas Company, of Melbourne. He introduced electric arc welding into Australia, his earliest achievement in this respect being the all-welded South Melbourne gasholder.

The Coal and Ore Dressing Appliances (1929), Ltd., 32, Victoria-street, London, S.W. 1, asks us to state that it is still in active operation for the design, manufacture and supply of coal washeries on the "Luhrig" principle. It has been reported that spares could no longer be obtained for the existing washeries and that manufacture had ceased. The firm desires to contradict these statements in all respects.

Coventry Climax Engines, Ltd., informs us that in connection with an extensive programme of development, which involves the manufacture of engines for cars, commercial vehicles and passenger coaches, and a series of engines for industrial purposes, the works and staff have been rearranged and the following appointments made:—Mr. J. W. Mills has been appointed general manager and Mr. W. P. Riley works manager. Mr. H. D. Turner will continue as an active director and have control of the sales. Mr. H. Hayward has resigned his position with this firm.